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Mobile Radio TechnologyTM

The journal of mobile communications technology

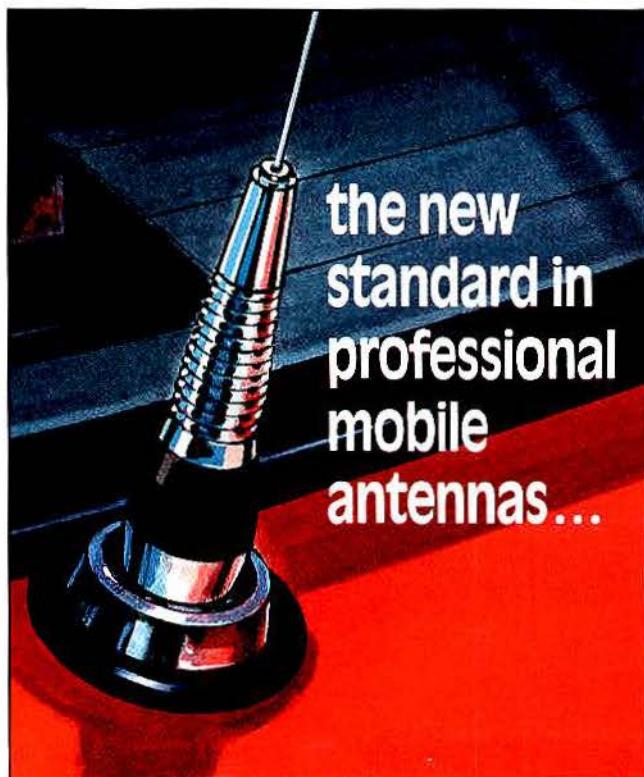
Cell-site testing, p. 10

Base antenna system testing
IMCE/Spring wrap-up





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10 Use automated testing for cellular base stations

Dave Wood

Enormous amounts of time can be saved by using the right hardware and software specifically written for cellular base station testing. In-service testing protects revenue and can lead to increased customer satisfaction.

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James M. Crooks

Two types of line sweeping equipment are suitable for feedline and antenna system measurements that detect deterioration and faults. Sample waveforms help to show you how to interpret test results.

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Nancy Campbell

Speakers in the opening session of the mobile communications industry's largest show talked about the converging technologies for personal communications. Here are some of their comments.

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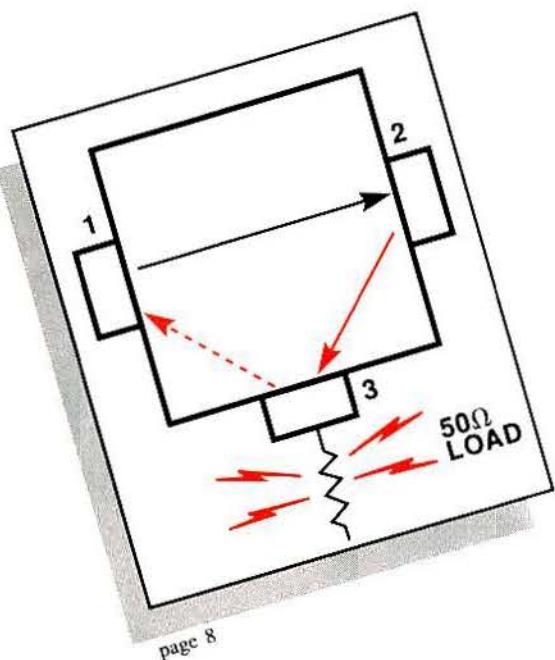
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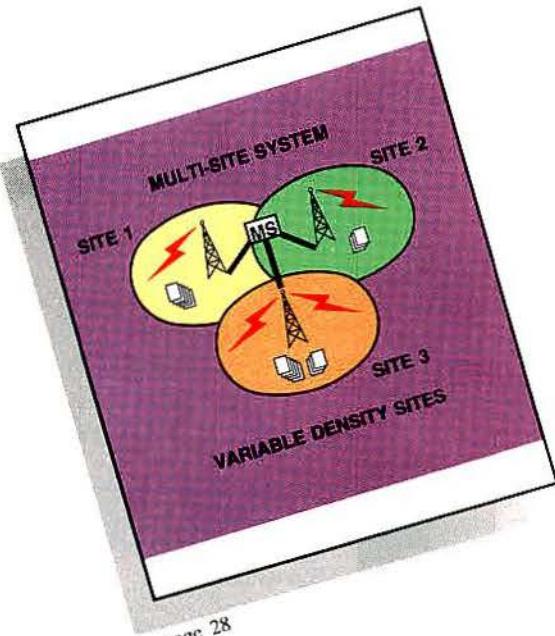
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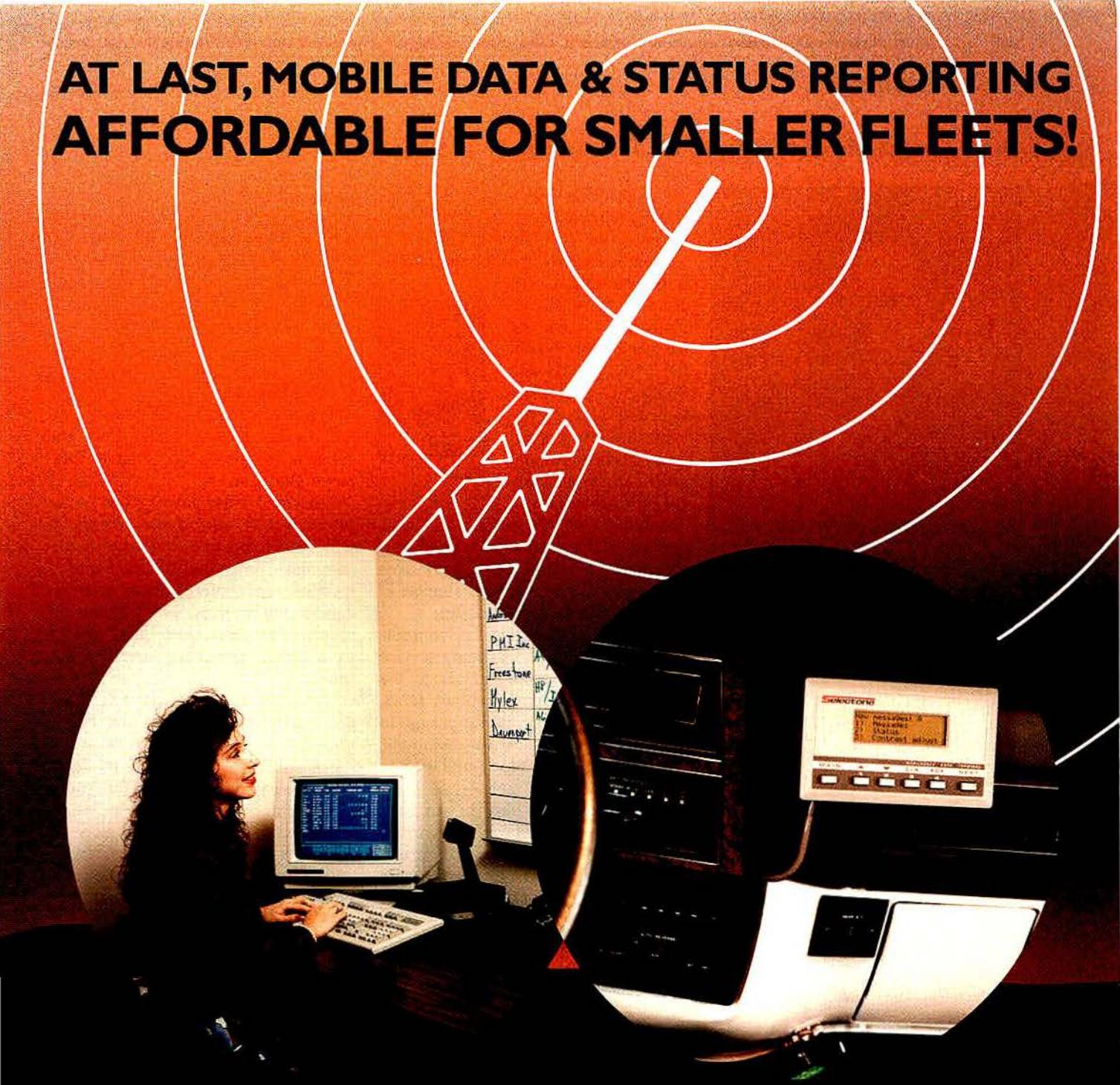


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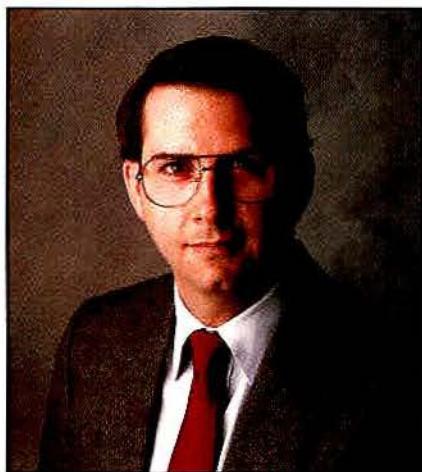
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Department of State officer is 'Technician of the Year'



Congratulations to Douglas A. Reno, the recipient of the 1993 Technician-of-the-Year Award.

Reno is employed as a communications electronics officer with the U.S. Department of State. He has served throughout the Middle East and South Asia and is stationed in Cairo, Egypt.

During his career, Reno has been responsible for the successful completion of communication systems for U.S. embassies. He has been commended continually for his high-quality work, professionalism and continued support in the operation of these systems.

He has demonstrated his commitment to providing outstanding service by performing radio services to the American embassy in Bombay, India, during a monsoon; participating in negotiations for antenna installations; and providing technical guidance to staff personnel.

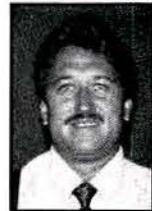
"Throughout his stay in Amman, Jordan, Doug always was ready to assist . . . no matter how difficult or trivial the problem was," a letter from Administrative Counselor Lee Lohman at the American embassy in Amman reads.

The award recognizes the vital role technicians play in the industry. It honors technicians who are actively employed in mobile communications and who have shown an outstanding effort in the performance of their duties. Candidates are assessed on their professionalism, performance, customer satisfaction and teamwork abilities.

As this was written, Reno was scheduled to be honored at a May 13 luncheon in San Antonio, TX, during the Mobile Comm '93 conference. He received an expenses-paid trip to the conference and an inscribed plaque.

The award and conference are sponsored by the National Association of Business and Educational Radio (NABER), Arlington, VA. NABER deserves a lot of credit for raising the visibility of radio technicians through

its award program. If you are interested in submitting nominations for next year's award, call Jan Jensen at 800-759-0300.



* * *

Last technician

The May issue's "Letters to the Editor" column included a letter from Rod Wheeler of the Radio Shop in Diamond Bar, CA.

Wheeler's letter gave a view of the future by the turn of the century in which the telephone companies dominate most forms of electronic communications and entertainment program distribution services. Small radio communications service-providers, unable to compete, have disappeared in this future.

Moreover, the same future finds radio equipment with such low failure rates and at such low prices that service facilities, having been rendered unnecessary, have disappeared, too.

We can see a future in which small radio communications service-providers and service facilities survive and prosper, although their roles may be different in 2000 compared to their roles today.

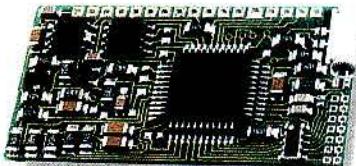
The radiopaging service, for example, has grown continually despite predictions dating from the '80s of its imminent obsolescence. It *does* appear to be poised to become one of the electronic networks that may serve portable computers.

We would like you to send letters responding to the "Last Technician" letter. Tell us your opinions about the future shape of radio communications services and the role of service facilities.

—Don Bishop

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June

29-July 1—Utilities Telecommunications Council Annual Meeting, San Antonio Marriott Rivercenter and Convention Center, San Antonio. Contact: Rita Clark, 301-621-7802.

July

18-22—Forestry-Conservation Communications Association, Jackson, WY. Contact: Don Pfohl, 602-644-3166.
24-28—International Municipal Signal Association, Norfolk, VA. Contact: Harold Glerum, 800-723-4672.

August

8-13—Associated Public-Safety Communications Officers 59th National Conference, New Orleans Convention Center, New Orleans. Contact: 800-949-2726.

September

21-23—International Mobile Communications Expo/Fall, Philadelphia Convention Center, Philadelphia. Contact: 303-220-0600.
28-Oct. 1—Mobile Communications Marketplace, New Orleans Convention Center, New Orleans. Contact: Telocator, 800-326-8638.

October

12-13—SMR/Private Carrier Management Conference, Loews Coronado Hotel, San Diego, CA. Contact: 202-331-7773.
16-21—International Association of Chiefs of Police Annual Conference, Cervantes Convention Center, St. Louis, MO. Contact: 703-836-6767.

November

4-6—Industrial Telecommunications Association Annual Meeting, La Quinta Hotel, La Quinta, CA. Contact: Barbara J. Levermann, 703-528-5115.
11-14—Communications Marketing Conference, Holiday Inn Riverwalk, San Antonio. Contact: Gene Johnson, Vega Signaling, 818-442-0782.

19—Radio Club of America Awards Banquet, New York Athletic Club, New York. Contact: 201-652-6811.

1994

February

7-8—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Marriott on International Drive, Orlando. Contact: 202-331-7773.

March

2-4—Cellular Telecommunications Industry Association Winter Meeting and Exposition, San Diego. Contact: 202-785-0081.
6-9—Energy Telecommunications and Electrical Association, Henry B. Gonzales Convention Center, San Antonio. Contact: 214-235-0655.

April

13-15—International Mobile Communications Expo/Spring, Las Vegas Convention Center, Las Vegas. Contact: 303-220-0600.

May

2-5—Supercomm and the International Conference on Communications, sponsored by the IEEE Communications Society, New Orleans. Contact: 800-326-8638.
25-27—RadioComm, Vancouver Convention Center, Vancouver. Contact: Bill Eggertson, 613-233-4888.

June

7-11—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Stockholm, Sweden. Contact: Professor Sven-Olof Ohvrik, technical chairman, 46 8 757 0483; Fax 46 8 34 8441.

18-23—Utilities Telecommunications Council Annual Meeting, Washington Sheraton, Washington, DC. Contact: Rita Clark, 301-621-7802.

Mobile Radio Technology

The journal of mobile communications technology

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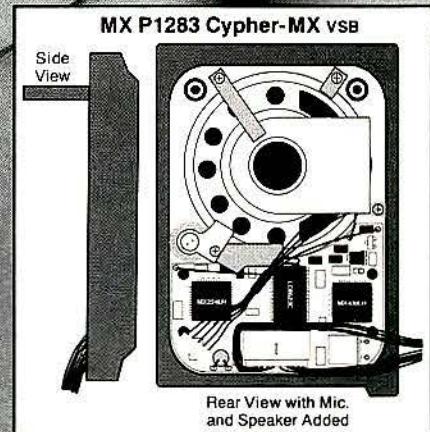
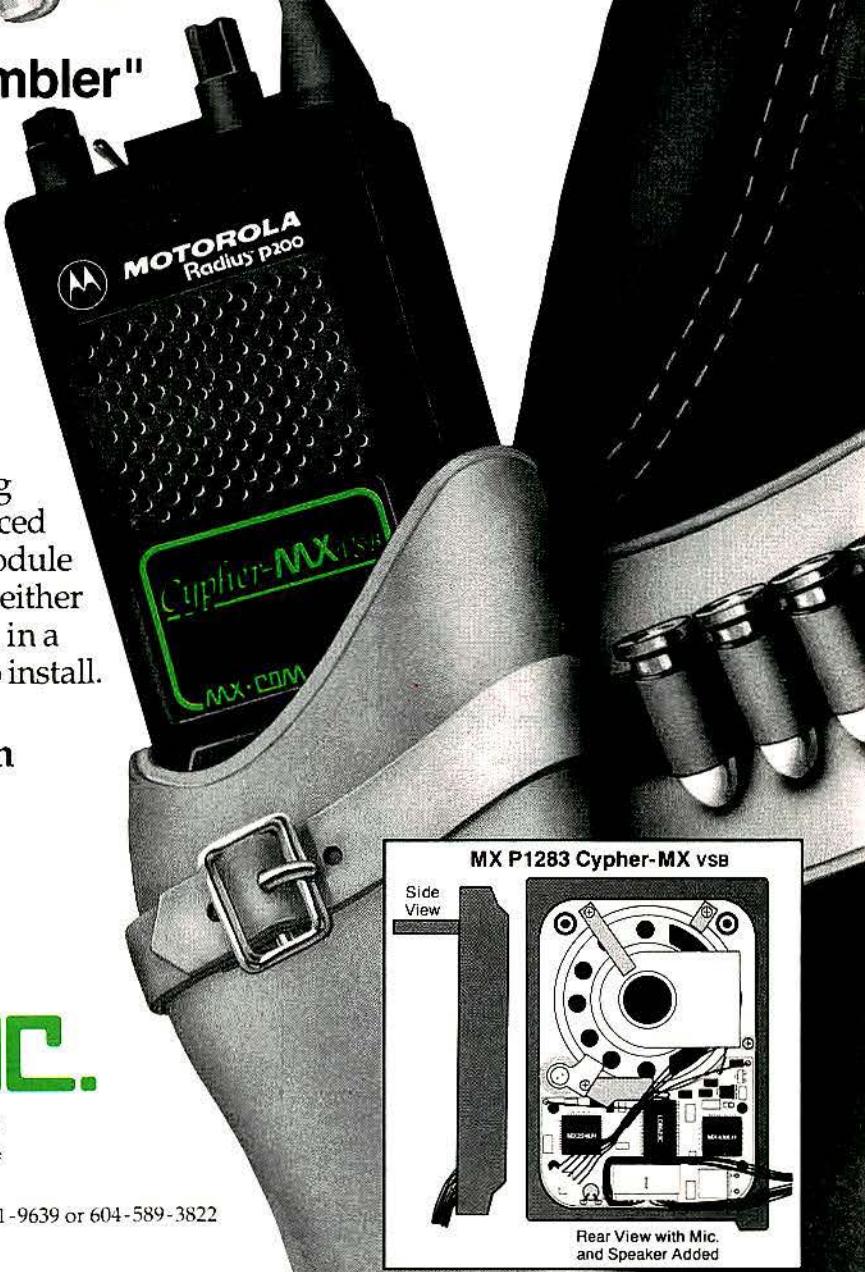
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Isolators—the practical view, part 1

By Harold Kinley, CET

The ferrite isolator has come into wide use in recent years.

Details on the isolators' practical use and benefits, as well as their care and feeding, can be helpful to technicians.

The reasons for using isolators include:

(1) reducing intermodulation products caused by signals mixing in the transmitter's non-linear class C output stage.

(2) providing a more constant 50Ω load impedance to the transmitter, which, in turn, reduces the possibility of spurious signal generation within the transmitter output stage.

It is not necessarily important to the technician how a ferrite isolator is designed and manufactured. For prac-

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

tical purposes, the device can be analyzed as a "black box." So long as the technician understands the isolator's overall function, its limitations, specifications, applications and benefits become clear.

A ferrite isolator is a ferrite circulator with a dummy load. Figure 1 below left shows a simplified drawing of a ferrite circulator with a load resistor at port 3.

Normally, port 1 is the input port; port 2, the output port; and port 3, the load or termination port. The load connected to port 3, the termination port, is equal to the system impedance—50Ω for land mobile radio systems.

Isolator power flow

RF power entering port 1 from the transmitter passes on to port 2 with little attenuation.

Any power reflected back to port 2 because of a mismatched antenna, feedline or duplexer would be routed to port 3 as shown by the red arrow in Figure 1.

If port 3 is terminated by an impedance equal to the system impedance, most of the power transferred to port 3 is dissipated as heat in the 50Ω dummy load. Any mismatch between the dummy load and port 3 causes a portion of the RF power at port 3 to be transferred to port 1, as depicted in Figure 1 by the broken red arrow.

The better the impedance match between the dummy load and port 3, the less RF power transferred from port 3 to port 1. Thus, the quality of the load connected to port 3 has a great bearing on the isolator's overall performance.

Typical isolator setup

Figure 2 below right shows a typical isolator setup.

A single-section isolator is shown connected between the transmitter output and the antenna. The forward power is represented by the black line, and the reflected power is represented by the red line.

Notice that the power reflected from the antenna (red line) is routed from

(continued on page 42)

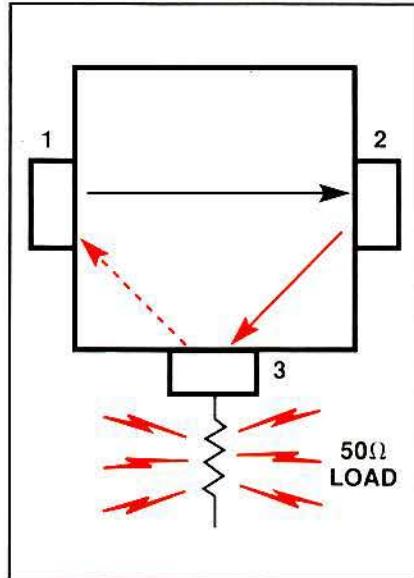


Figure 1. This single-section isolator consists of three ports. Port 1 is the input port; port 2, the output port; and port 3, the load or termination port. Forward power flows from port 1 to port 2. Reflected power flows from port 2 to port 3, where it dissipates in the 50Ω load resistor. A mismatch at port 3 causes some of the power to be transferred back to port 1.

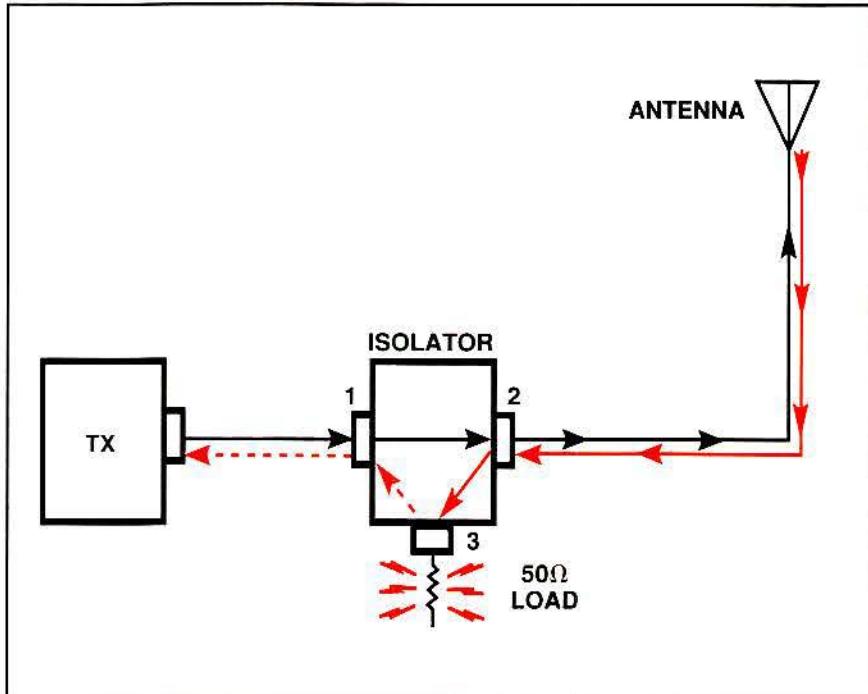


Figure 2. A single-section isolator is connected between the transmitter output and the antenna. Reflected power, indicated by red, is 'dumped' into the load resistor at port 3. A small portion of the reflected power finds its way back to port 1 and back into the transmitter.

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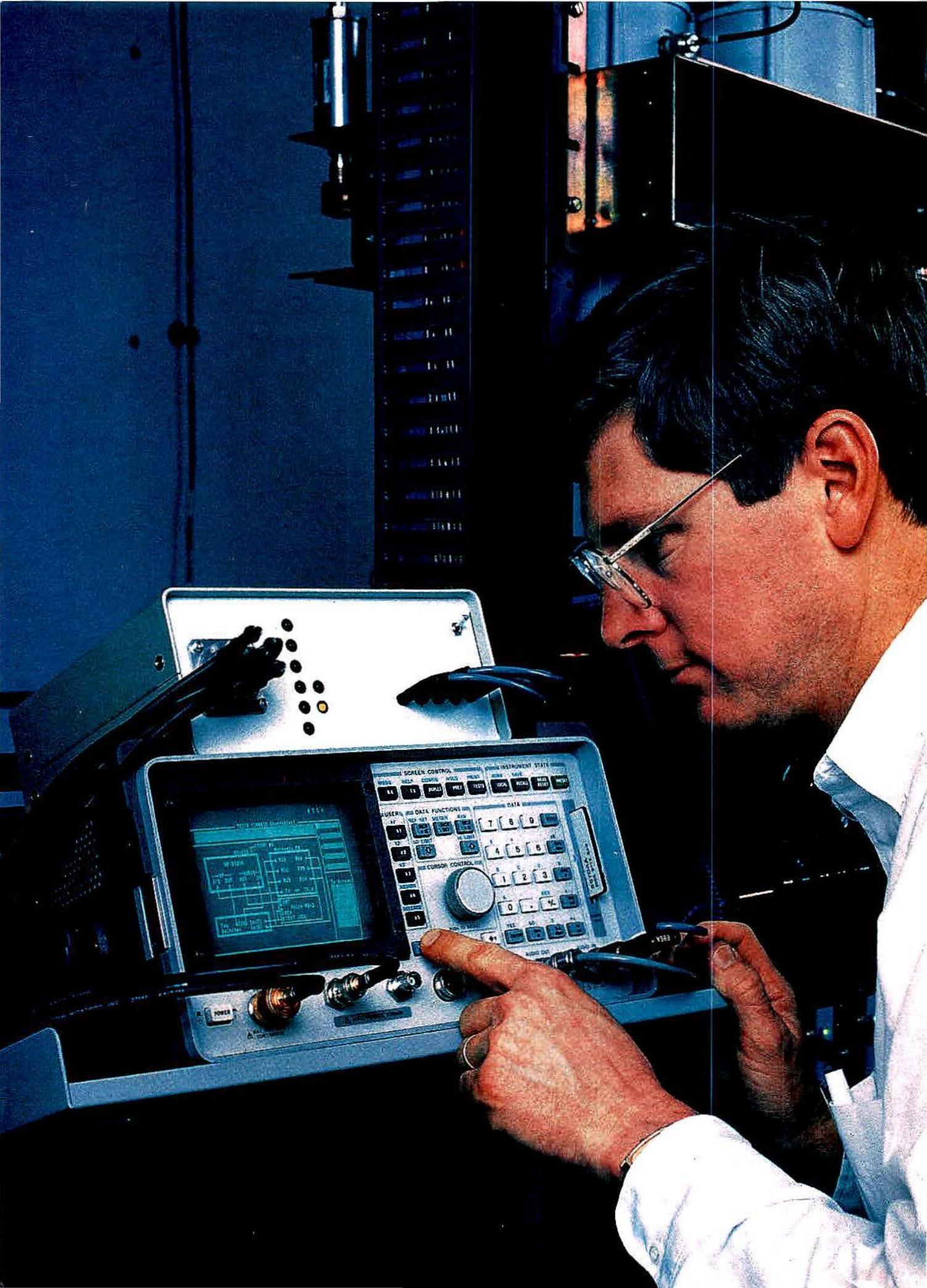
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Use automated testing for cellular base stations

Enormous amounts of time can be saved by using the right hardware and software specifically written for cellular base station testing. In-service testing protects revenue and can lead to increased customer satisfaction.

By Dave Wood

As cellular systems mature, with attendant cell splitting, micro cell structures and phenomenal growth, the maintenance of these systems grows increasingly complex.

The typical system operator is faced with trying to balance construction activities with maintenance requirements while still delivering a superior grade of service. Both of these activities draw heavily upon the precious resource of time.

Cellular systems, by their nature, are massively trunked communications systems. One bad voice channel can affect thousands of conversations during the course of a day, thereby generating hundreds of trouble reports.

This kind of problem results in even more demands on that precious commodity of time. Any technique that reduces maintenance time translates directly into improved customer service.

Recent advances in technology have allowed the automation of cellular base station maintenance. The automation process has created significant time savings for the system operator, resulting in improved service.

The following information is a guide to the implementation of automatic base station testing. It includes a case history of Sprint Cellular's solution to

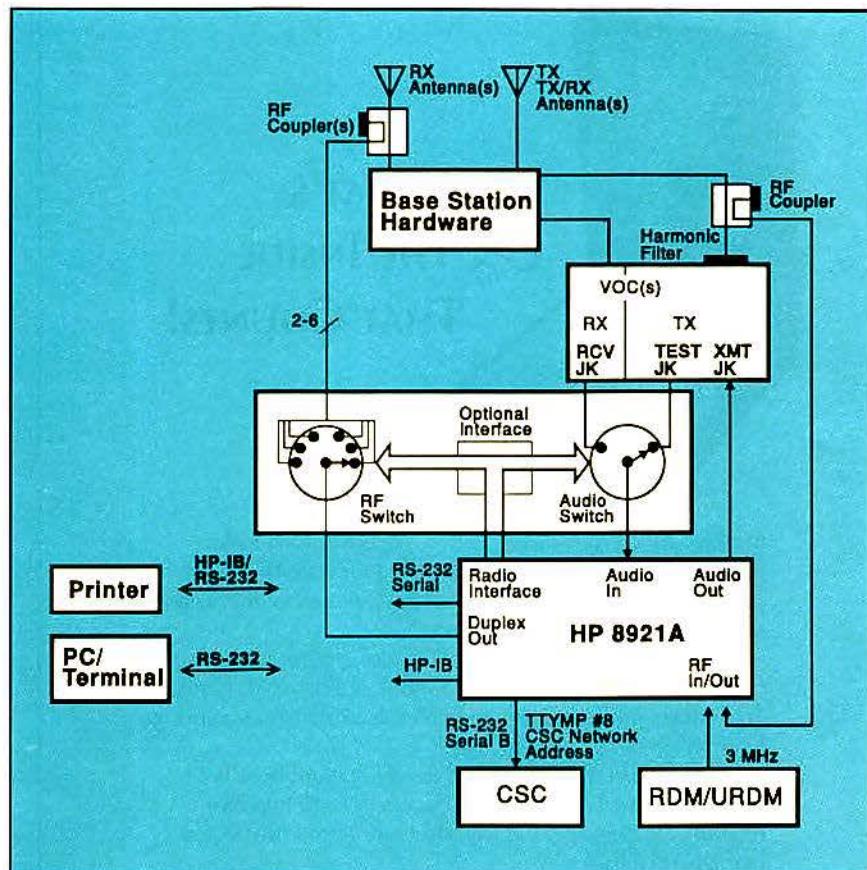


Figure 1. A typical system interconnect. Note the automatic control of RF and audio lines which eliminates most manual hookup chores.

automated testing.

Tremendous growth along with a desire to standardize maintenance procedures led to the need to automate as many base station testing procedures as possible. When one analyzes the time spent on base station maintenance, two factors stand out immediately.

First, the most unproductive time is consumed while driving to the cell site.

Second, base station hardware testing takes much longer than actual repair.

Any automatic maintenance process should address these time-consuming actions to increase productivity. With this in mind, the following criteria have been established for a proposed automated cell site maintenance package:

- (1) The process must be accurate and reproducible.

Wood is network training manager for Sprint Cellular in Raleigh, NC, and is responsible for base station and switch training. He has more than 20 years of experience in land mobile radio and telephone communications systems.

(2) The procedures must adhere to the manufacturer's recommended maintenance practices plus offer substantial enhancements.

(3) The process must reduce maintenance time by several orders of magnitude to have the desired productivity effect.

(4) The process should be user friendly and should be structured to

enhance field acceptance, i.e., a single-box solution.

(5) Detailed maintenance records should be available to allow easy trending analysis and maintenance tracking.

(6) The process should have as little effect on revenue as possible; i.e., it should support in-service testing.

(7) The software should be structured to minimize operator error.

A search for the necessary hardware and software led to Hewlett-Packard's HP 8921A service monitor as the best solution for Sprint Cellular's testing requirements.

The two companies made an agreement: Hewlett Packard provides the necessary software and testing expertise, and Sprint Cellular provides the necessary system expertise.

Company representatives decided to develop test software in the field on a working system. This method helps to tailor the software to "real world" situations that occur with a loaded system. An added benefit would be reduced software debugging time.

Sprint Cellular uses the Motorola HD-II/LD base station platform exclusively. This platform is an intelligent software-driven cellular base station. The integrated maintenance software package is extremely advanced and lends itself well to automated testing.

Within the HD-II architecture, voice channels are tested as part of the system and not as stand-alone entities. As such, base station testing must be accomplished from a system point of view because it is not possible to test a radio channel as a stand-alone radio.

At first glance, this might seem to be less than optimum; nevertheless, this approach really is the best because the voice channel is tested exactly as it is used by a customer.

After a 9-month development period, nine automated base station tests were implemented. These tests represent the core of Sprint Cellular's base station maintenance strategy. These tests are:

- (1) Laptop emulator.
- (2) RDM frequency and level.
- (3) Voice transceiver.
- (4) Signaling transceiver.
- (5) Scanning transceiver.
- (6) Combiner adjustment.
- (7) Wideband data on voice channel.
- (8) Manual switch and calibration aid.
- (9) Calculate transmitter power.

By running these tests either singularly or in combination, all necessary base station criteria are tested and documented.

The nine tests are stored on a random-access memory (RAM) card



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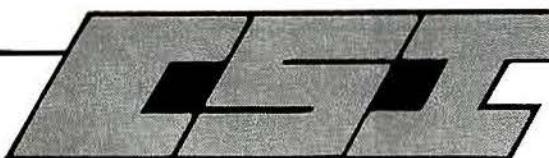
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and loaded into the HP 8921A's I-Basic computer, which takes control of the base station's maintenance package via an RS-232 interface.

RF and audio switching is accomplished by a Sprint Cellular-designed switching matrix controlled by the HP 8921A. The switch box eliminates most manual cable hookups, thus eliminating a large source of operator error. Indeed, all test setups are controlled by software, completely eliminating measurement errors produced by incorrect operator inputs.

Equipment setup is a straightforward process. Figure 1 on page 11 shows how the HP 8921A controls the HD-II base station via an RS-232C connection to the master cell site controller. Various maintenance commands are sent to the base station via test software to accomplish test goals.

RF is coupled into and out of the base station by way of directional couplers with a nominal coupling value of 30dB. Sprint Cellular chose the RLC model 3020A directional couplers be-

cause of their maximally flat coupling response (typically 0.1dB from 800MHz to 900MHz) and reasonable cost.

RF is coupled from the HP 8921A's duplex port via the Sprint Cellular

tested at the same time. This method eliminates a great deal of mechanical cabling, and because of the Motorola architecture, it allows all voice channels in one bay to be tested without recabling for RF signals. It greatly reduces test time and reduces chances of operator error.

In addition to RF, audio signals required for testing are automatically routed by software and the matrix switch.

Test results can be directed to a printer using the HP-IB interface or can be sent to a serial printer using the uncommitted second serial port on the HP 8921A. In addition, results can be uploaded to a laptop using readily available terminal software or can be stored on RAM memory cards for later retrieval.

The nine tests that have been developed are described below. These tests are individual in nature and are usually run singularly.

Nevertheless, at the operator's discretion, they can be grouped together

*The switch box
eliminates most manual
cable hookups, thus
eliminating a large
source of operator error.*

matrix switch to either six or two base station receiver inputs, depending on cell-site configuration. At the same time, RF from the base station transmitters is coupled into the HP 8921A's RF In/Out port.

Thus, full-duplex testing occurs, allowing both the transmitter and receiver portion of a transceiver to be



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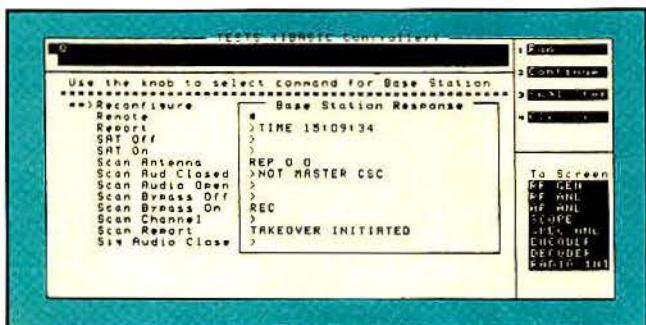


Figure 2. Initial RS-232 session with the HD-II base station. In this case, the site was re-configured to allow proper control of voice transceivers.

in any order desired. For clarity, the tests are described in numerical order, although the test number has no bearing on test importance or function.

► *Test No. 1* is the laptop emulator.

The operator uses this program to communicate to the Motorola base station during static conditions, i.e. no automatic process running. This program is helpful in establishing communications with the base station and initializing certain pretest conditions.

A prepackaged list of the most used maintenance commands can be accessed from the program. This frees the operator from having to know system syntax because the program prompts for the proper input.

This feature saves valuable time by not requiring reference to Motorola software documentation for input syntax. Any command not on the command list can also be sent manually to the base station. Refer to Figure

2 above for a display of a typical laptop emulator session with the base station.

► *Test No. 2* is the reference distribution module (RDM) frequency- and level-setting test.

In the Motorola architecture, RF output frequencies are referenced to a master 3MHz oscillator. It is important to ensure that these references are properly set or an off frequency condition could exist.

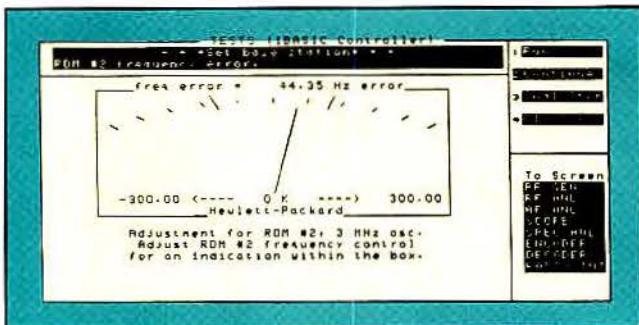


Figure 3. Large analog meter displays base station frequency error. Note adjustment instructions located below the meter. Adjustment aids such as these free operators from having to consult documentation to make adjustments.

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Figure 4. Standard print-out of one voice transceiver test. Testing time was extended to four and a half minutes due to test failures. In addition to the three maladjustments found, this transceiver had a defective RF section and had to be returned to the manufacturer for repair.

Optimization tests for Motorola LD & HDL base stations.				
Test conditions	Measured value	Lower limit	Upper limit	P/F
Voice transceiver K1_2 at Channel=6525:SAT=5002 Hz				
Present Rx antenna is number 1				
RX audio output	-17.67 dBm	-18.10	-17.80	FAIL
**Re-measure of the audio output				
RX audio output	-18.00 dBm	-18.10	-17.90	
RX SINAD @ -122 dBm	-14.3 dB	-12.0		
Present Rx antenna is number 2				
RX SINAD @ -122 dBm	-2.3 dB	-12.0		
Present Rx antenna is number 3				
RX SINAD @ -122 dBm	-4.6 dB	-12.0		
Present Rx antenna is number 4				
RX SINAD @ -122 dBm	-1.6 dB	-12.0		
Present Rx antenna is number 5				
RX SINAD @ -122 dBm	-4.0 dB	-12.0		
Present Rx antenna is number 6				
RX SINAD @ -122 dBm	-4.0 dB	-12.0		
Present Rx antenna is number 1				
RX audio distortion	0.1		5.0	
RX hum and noise	51.3 dB	40.0		
RX expander resp @ -12.0 dB	-1.8 dB error	-1.0	1.0	
RX expander resp @ -10.0 dB	0.0 dB error	-2.0	2.0	
RX audio resp @ .38 kHz	-1.0 dB error	-6.0	1.0	
RX audio resp @ 3.00 kHz	-3.0 dB error	-6.0	1.0	
RX signal SAT @ 6002 Hz	6000	6000		
No signal SAT @ 6002 Hz	WRONG	6000		
RX signal ST detect	6000	6000		
RX signal ST detect	WRONG	6000		
Tx frequency error	42 ppm	-1.00	1.00	
Tx power & level 0	10.15 Watts	10.70	25.30	
Tx SAT freq err @ 6002 Hz	0.00	-5.00	5.00	
Tx SAT pk dev @ 6002 Hz	2.09 kHz	1.00	2.00	
Tx TEST JACK output	-20.00 dBm	-21.00	-19.00	
Tx pk+voice lim @ 1 kHz	10.05 kHz		12.00	
Tx pk+voice lim @ 1.1 kHz	11.05 kHz		12.00	
Tx pk+voice lim @ 1.1 kHz	10.62 kHz		12.00	
Tx pk+voice lim @ 1.1 kHz	11.11 kHz		12.00	
Tx pk+voice lim @ 1.2 kHz	10.95 kHz		12.00	
Tx pk+voice lim @ 1.2 kHz	11.71 kHz		12.00	
Tx pk+voice lim @ 1.3 kHz	10.74 kHz		12.00	
Tx pk+voice lim @ 1.3 kHz	11.71 kHz		12.00	
Tx pk+voice deviation	2.88 kHz	2.85	2.95	
Tx pk+voice deviation	2.89 kHz	2.85	2.95	
Tx audio distortion	0.1		5.0	
Tx hum and noise	54.4 dB	40.0		
Tx comp track err @ -10 dB	-0.03 dB error	-0.50	.50	
Tx comp track err @ -10 dB	-0.14 dB error	-1.00	1.00	
Tx audio resp @ .38 kHz	-1.4 dB error	-3.0	1.0	
Tx audio resp @ 3.00 kHz	-1.0 dB error	-4.0	1.0	

In addition, this reference frequency is used to drive most processor cards and is thus level sensitive. As in all tests, a large analog meter is brought up on the CRT for adjustment purposes. This metering is in addition to auditory feedback for the operator, who may not be positioned to easily see the HP 8921A screen.

Automated RDM tests and adjustments can be accomplished in approximately five minutes. See Figure 3 on page 16 for an example of base station frequency adjustment.

► **Test No. 3** is the voice transceiver test.

In reality, the voice transceiver tests are the heart of the entire automated process, as transceivers are the most numerous system components and have the greatest impact on customer perceptions. To ensure the best grade of service possible, additional tests beyond the manufacturer's recommendations are performed on each voice channel in a system.

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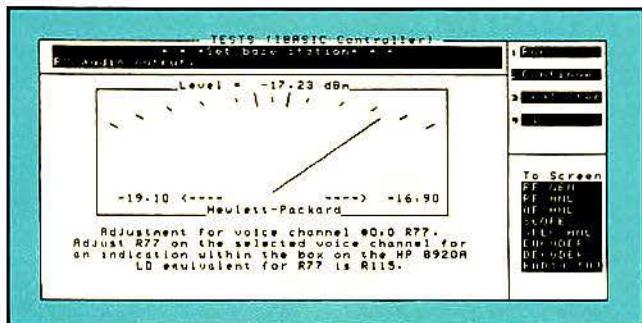


Figure 5. Analog meter display of transceiver audio output level. In addition to the display, auditory feedback is provided to allow easier setting of adjustments.

20 document which spells out performance requirements for cellular equipment providers. Referring to Figure 4 on page 18, note that a total of 38 individual tests were performed on this voice transceiver.

Extended tests such as hum and noise; compander tracking; audio distortion; and pre-emphasis and de-emphasis curve tracking have been added to the standard list of tests. In the past it was not possible to run the

extended test manually because of the tremendous time required to set up these procedures!

As with all tests, large analog meters are brought up on the HP 8921A screen to allow adjustments along with auditory feedback to facilitate adjustments. Figure 5 above left illustrates receiver output level setting.

Another useful function is the inclusion of component locator maps to guide the operator in making adjust-

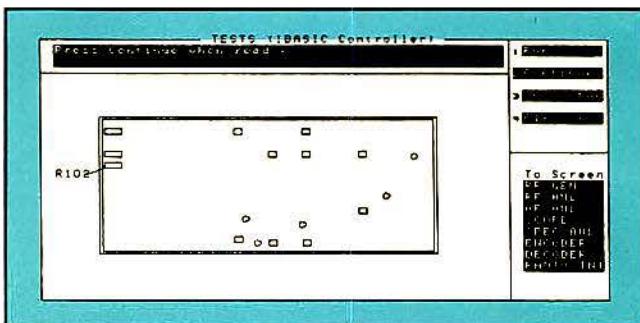
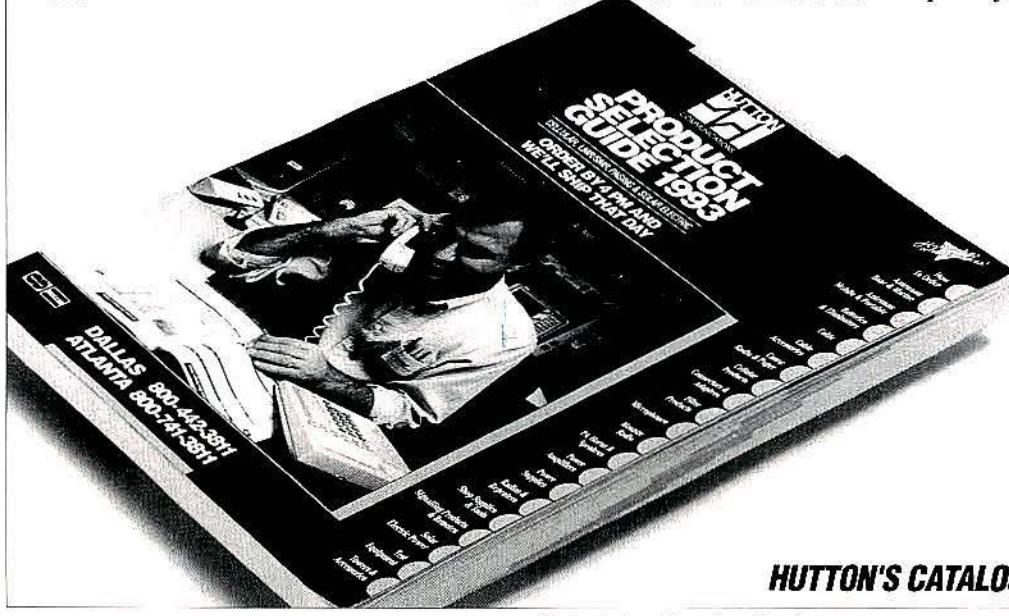


Figure 6. Typical locator map showing transceiver adjustment locations. This particular map is for the front panel transmitter audio level adjustment pot.

ments. Figure 6 above right illustrates this function. The locator maps support both HD-II and LD transceivers.

A typical session with a voice transceiver can be completed in approximately four minutes. This reduction of testing time represents several orders of magnitude of improvement over manual methods. Note that voice transceiver tests can be run while the site is in service, thereby reducing impact on revenue flow.

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► Test Nos. 4 and 5 are the signaling channel and scanning receiver tests, respectively.

Both the scanning receiver and signaling transceivers require the calibration of signal strength indicator (SSI) curves. In newer units, this calibration is done in base station software to gain more accuracy.

Large software tables are con-

structed that correct for system gain inaccuracies. The manual calibration of these tables is a long and tedious process and is very error prone. Automation of this process is a godsend to the maintenance staff.

The HP 8921A can calibrate Scan II receivers completely without operator intervention in a little less than 35 minutes. This calibration includes SINAD

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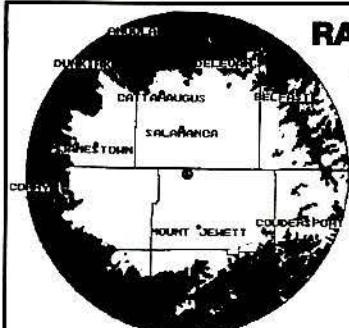
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Figure 7. Partial printout of HD-II Scan II receiver calibration run. Note the numerous failures and that the program is automatically correcting these data points. Motorola scan receivers are typically calibrated at -90dbm.

testing of six sector antennas, supervisory audio tone (SAT) detection, calibration of six sector receive antenna inputs and linearity checks.

Signaling transceiver test and calibration occurs in a little less than five minutes. Both *scanning receiver* and *signaling transceiver* tests require an out-of-service cell condition; therefore, program speed is most important if the effect on revenue is to be minimized.

Refer to Figure 7 above for a scan receiver printout and calibration run. Note the numerous failures that the program is correcting by itself.

► Test No. 6 is the combiner tuning test.

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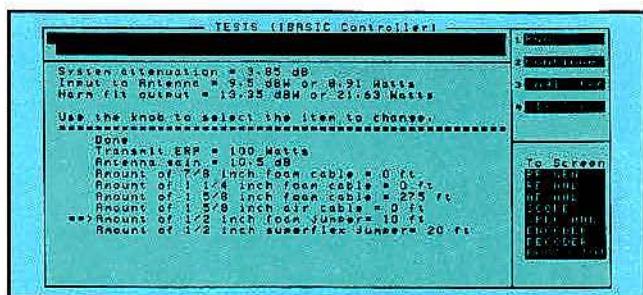


Figure 8. Typical output from the transmitter power calculation program. Here, to provide an ERP of 100W, with losses as shown, it is necessary to run 21.63W at the harmonic filter output.

Actually it is a subset of the voice transceiver test, No. 3. The program takes control of the voice transceiver and allows manual keying of the channel for combiner tuning purposes.

► **Test No. 7** is a wideband data deviation test.

It allows wideband signaling data to be measured with the voice transceiver in service. The HP 8921A captures data bursts on the fly and follows calls from channel to channel allowing wideband data to be easily measured on each voice channel in a cell site.

Note that this is actual data, not a facsimile.

► **Test No. 8** is a calibration aid for the HP 8921A to allow easy calibration of external RF signal path losses. These losses are entered into the parameter fields in the program and are used to calculate various measurement results.

► **Test No. 9** is a transmitter power calculation program.

It allows the operator to calculate transmitter power output at the stack for various ERP FCC requirements. This program is unique in that it recalculates output power instantly as various losses are introduced into the antenna system.

Figure 8 above illustrates a typical transmitter power calculation.

The nine tests briefly described above have proved to be so successful that they are now available as a standard software package for the HP 8921A. This software product HP 11807B option 040 comes to the user on smart cards and is loaded into the HP 8921 through the front panel card slot. This software has been purchased by Sprint Cellular for all markets and is now a network standard.

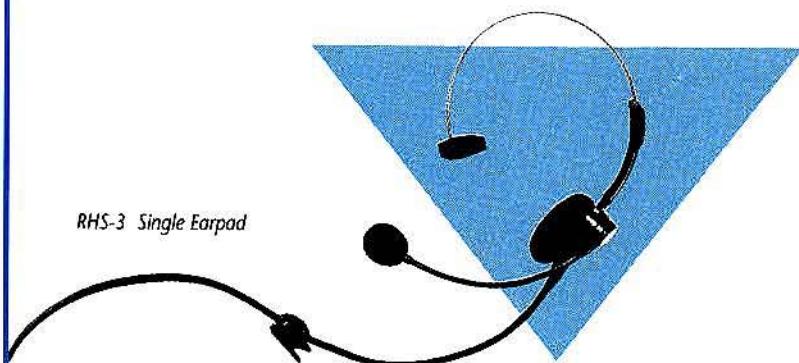
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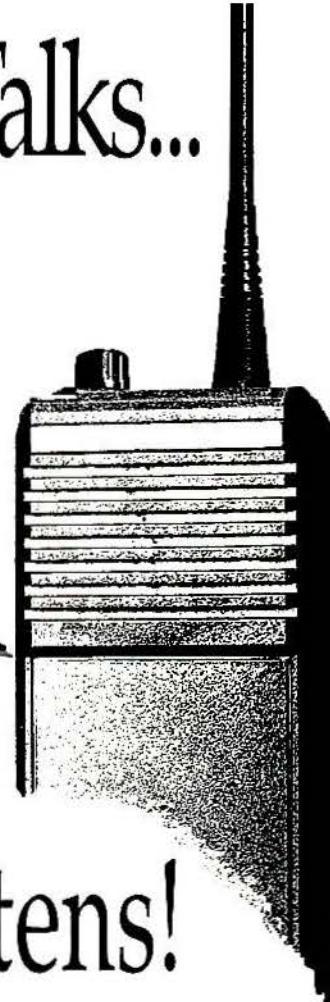
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their familiarity with the software.

Training for the HP 8921A and associated software is provided by Sprint Cellular's Network Training department and takes approximately one week. The response from our maintenance staff has been overwhelmingly positive, and field acceptance has been strong.

Many purists object to the reduction of accuracy that occurs when testing a cell site that is actively processing calls.

An RF-savvy person may object to the use of directional couplers to inject signals as well as to measure transmitter power. The main disadvantage of injecting signals into a cell-site receiver is that co-channel or adjacent-channel interference may be present, thereby corrupting measurement results.

In reality, experience has shown that detecting interference during testing benefits the system operator because interference needs to be addressed by frequency planning. It is also apparent

that the directional coupler's coupling values may vary somewhat if the antenna does not present a 50Ω impedance to the coupler.

If this is the case, one needs to find out what is wrong with the antenna system, because it should present a 50Ω load to the coupler's antenna port.

Another area of concern with in-service testing deals with measuring transmitter power with a spectrum analyzer. Here, absolute level accuracy and flatness come into play.

Most of these areas are calibrated out of the measurement picture; however, experience has shown that accuracies on the order of $\pm 0.4\text{dB}$ are common. Because the EIA spec for transmitter power is $+1, -3\text{dB}$, this is an acceptable compromise.

Those who want a more accurate measurement can use the out-of-service testing of transmitter power, as the program supports both methods.

Automated cellular base station testing is a natural and necessary evolution. It will be the only way most

service-providers will be able to provide adequate maintenance while controlling costs.

As this article is written, other test equipment manufacturers are fielding comparative products. Most, including Hewlett-Packard equipment, provide solutions for platforms in addition to Motorola's.

Because of the capital expense involved, it is important that the system operator carefully evaluate all products to ensure that they will meet current and future needs.

All automatic testing programs look impressive when compared to manual methodologies. The best evaluators are most likely the maintenance staff because they are closest to the problem.

Do not be afraid to have specialized software written for specific requirements. The proper selection of an automated test equipment vendor will translate into improved customer satisfaction, which is the reason service providers are in business.



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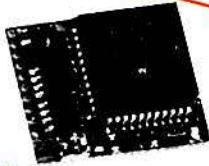
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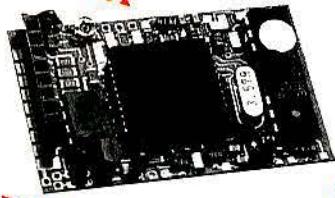
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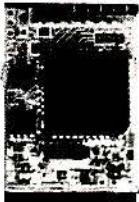
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How to use line sweeping to maintain antenna systems

Two types of line sweeping equipment are suitable for feedline and antenna system measurements that detect deterioration and faults. Sample waveforms help to show you how to interpret test results.

By James M. Crooks

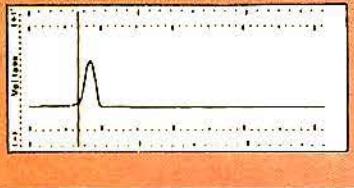


Figure 1. A properly TERMINATED cable absorbs the TDR signal, resulting in no reflection. Faults located ahead of the termination may be revealed as reflections along the waveform. If a terminator causes a reflection, the termination may be bad.

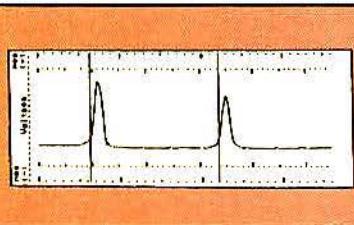


Figure 2. A reflection with the same polarity indicates a fault with OPEN (high impedance) tendencies. The reflection shown at the second cursor is a COMPLETE OPEN.

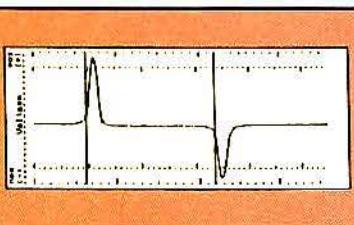


Figure 3. A reflection with the opposite polarity indicates a fault with short (low impedance) tendencies. The reflection shown at the second cursor is a DEAD SHORT.

There appears to be a lot of confusion in the communications industry concerning transmission lines, antennas, connectors, waveguides and when and where to use time-domain reflectometers (TDRs) and frequency-domain reflectometers.

The right information helps to dispel some of the misconceptions and helps technical supervisors to make important decisions about antenna system maintenance.

TDR

A TDR works on the same principal as radar: Pulses are transmitted down the cable under test and a part or most of the pulse energy is reflected.

The time required for the pulse to reflect and return to the source can be measured and plotted to provide a meaningful indication.

Time domain reflectometry is useful in three main areas of feedline and antenna system work:

- *Design*—It identifies impedance discontinuities.
- *Assembly and testing*—It aids in tuning.
- *Installation and maintenance*—It helps in fault location.

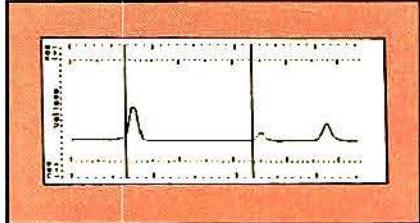


Figure 4. The middle reflection at the second cursor is a PARTIAL OPEN followed by a COMPLETE OPEN (end of the cable). The more severe the fault, the larger the reflection.

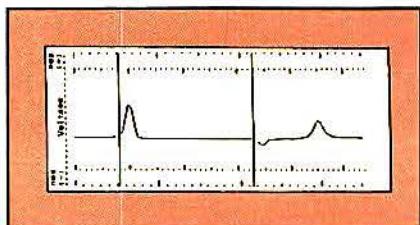


Figure 5. The middle reflection at the second cursor is a PARTIAL SHORT followed by a COMPLETE OPEN (end of the cable). The more severe the fault, the larger the reflection.

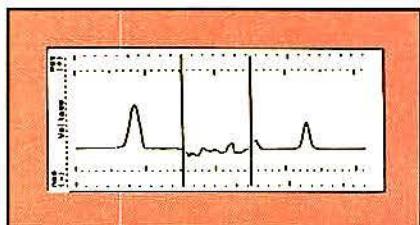


Figure 6. A water-soaked cable displays a waveform with a downward slope, indicating the beginning of the water, and an upward rise at the end of the water. Generally, the area in between the two reflections appears 'noisy'.

Crooks is president of Broadcast Communications, New Glarus, WI. He is a former chairman of the Wisconsin State 9-1-1 Board. He has been in the communications industry for 37 years, designing and installing systems for a wide variety of users.

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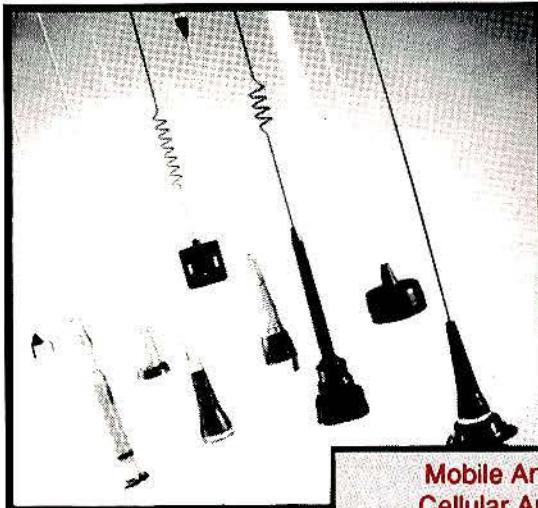
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Installation and maintenance is the most common use of a TDR.

Source pulse

The source pulse amplitude and duration determine its energy content and the maximum cable or line length that can be measured.

Pulse amplitude usually is fixed by the manufacturer and cannot be changed by the operator. Pulse width usually is adjustable via a preselection control that allows the operator flexibility.

The wider the pulse, the longer the feedline that can be accurately measured. There is a trade-off, though: A *blind spot* at the beginning of the pulse can mask discontinuities.

With a 2nS (2 nanoseconds or two billionths of a second) pulse, the blind spot covers approximately 3 feet; a

The source pulse amplitude and duration determine its energy content and the maximum cable or line length that can be measured.

10nS pulse has a 15-foot blind spot; and a 1,000nS pulse has a 600-foot blind spot. No return pulses are evident in the blind spot, so no faults are displayed within those sections of feedline.

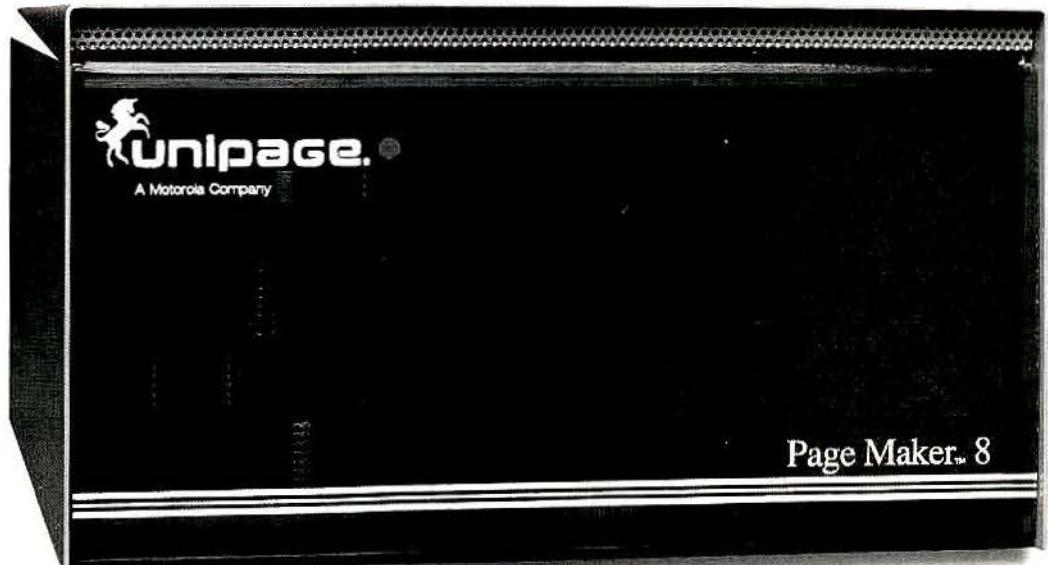
One way to overcome the blind spot is to insert a jumper cable equal to the blind spot length between the TDR and the feedline to be measured. With a 2nS pulse, the jumper is 3 feet long. To calculate the distance to a fault or the feedline length, jumper cable length is subtracted from the TDR fault indication.

Reflected pulse

The reflected pulse amplitude always is less than the source pulse

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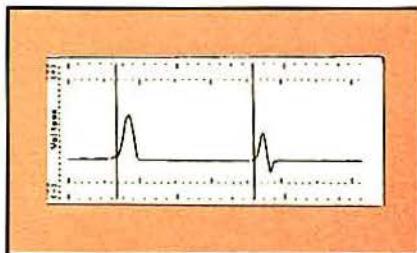


Figure 7. A HIGH RESISTANCE JOINT or SPLICE produces an S-shaped reflection. A high-impedance UPWARD reflection is followed by a lower-impedance DOWNWARD reflection.

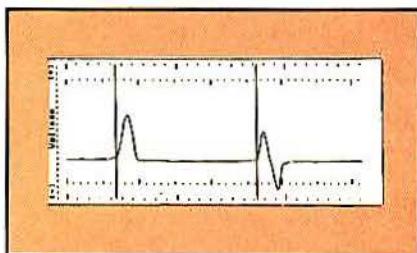


Figure 8. Testing through to an antenna usually results in an S-shaped reflection, although reflections can vary greatly depending on the antenna.

amplitude because of signal loss in the cable.

Keep in mind that the outgoing pulse is attenuated by line loss, and the *return* or *reflected* pulse is attenuated by the same amount.

Most TDRs present a positive-going source pulse, and the reflected pulse is either plus or minus, depending upon the return pulse's phase. Assuming a 50Ω source impedance, a positive return pulse indicates a reflected impedance greater than 50Ω (partial open or complete open of cable), and a negative return pulse indicates a reflected impedance less than 50Ω (kinks or water in the line or a partial short).

No reflection normally indicates a perfect 50Ω load that absorbs all of the pulse energy. An antenna connected to the line generally displays both a positive- and a negative-going pulse depending upon the antenna design and operating frequency.

TDR limits

Four important limitations should be

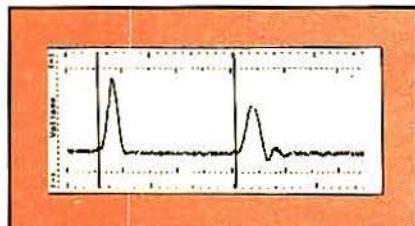


Figure 9. Testing tower cables with antennas can be challenging because of energy induction from high-RF areas as shown on the waveform. Stepping through various noise filter settings results in a cleaner waveform.

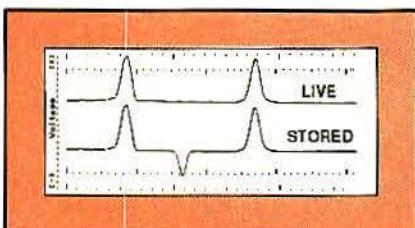
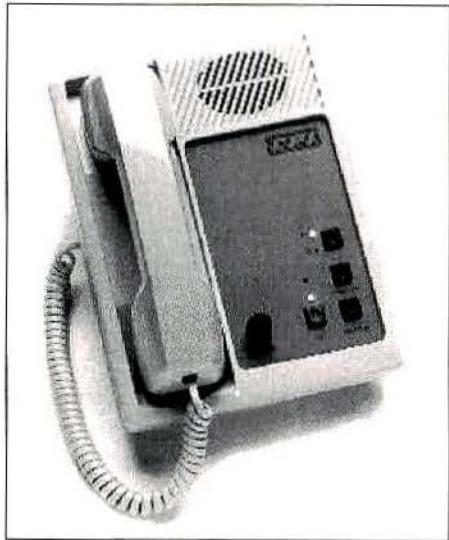


Figure 10. Some TDRs store images to allow an operator to compare the initial trace with another trace made after making a repair and print both traces as a permanent record.

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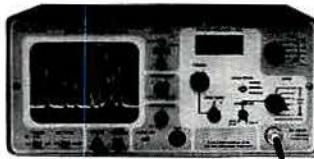
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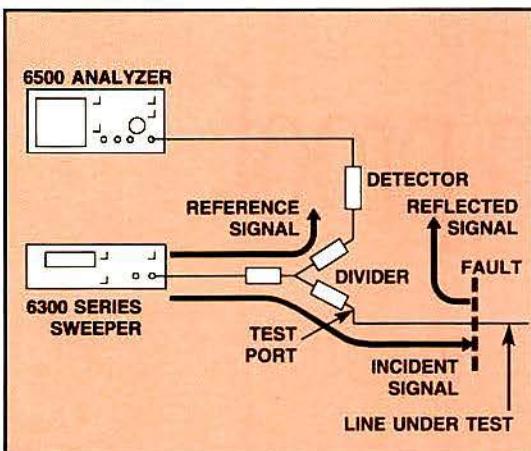


Figure 11. A scalar FDR setup block diagram for measuring distance to fault.

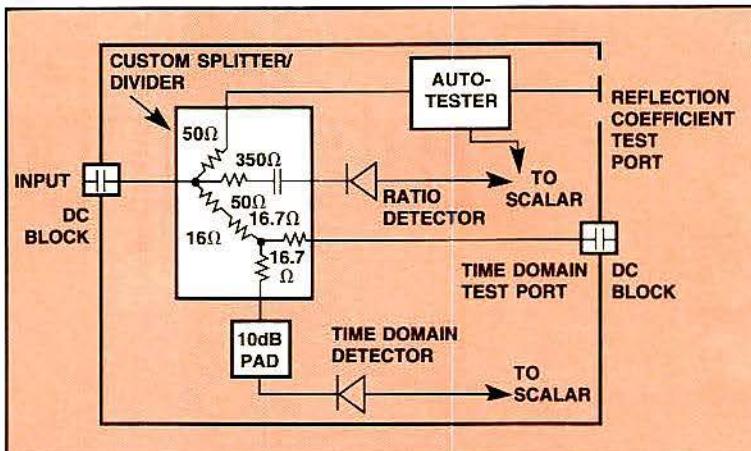


Figure 12. A scalar FDR setup block diagram for a directional coupler test head.

considered when using a TDR:

(1) The transmission line is pulsed at the TDR's pulse frequency, not at coaxial feedline's operating frequency. Some line faults are frequency-sensitive and may not be detected by a TDR.

(2) An antenna cannot be checked for resonant frequency by a TDR.

(3) Waveguide cannot be measured by a TDR because of the waveguide's dispersion effects.

(4) The actual return loss of a coaxial line cannot accurately be measured by a TDR.

Although a TDR has limitations when used with radio communications systems, it provides sufficient informa-

tion in as much as 80% of transmission line applications, including:

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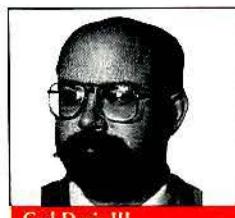
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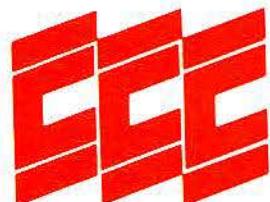
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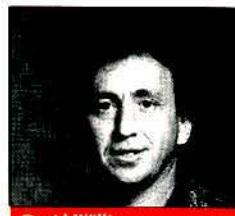
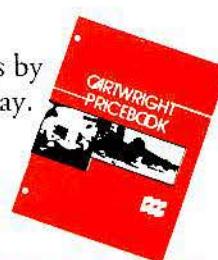
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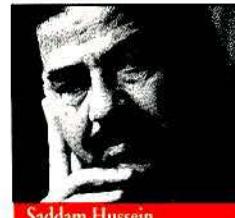
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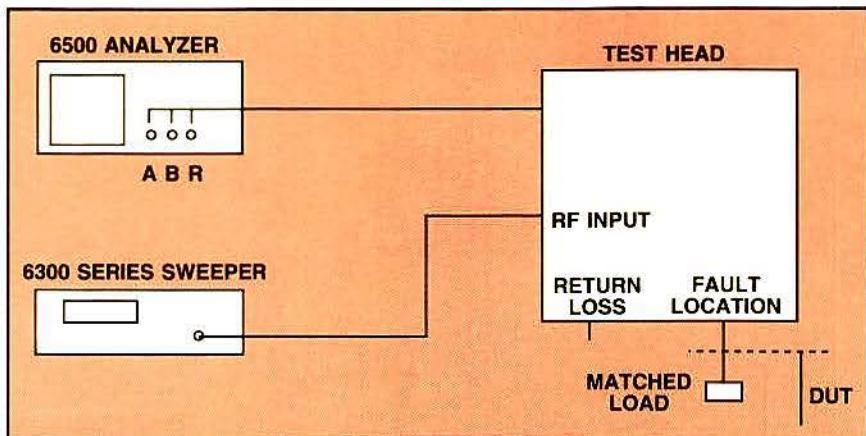


Figure 13. A scalar FDR setup block diagram for making insertion loss, return loss, VSWR, and antenna resonance measurements.

to \$5,000.

The display can be as simple as a footage counter or as elaborate as a liquid crystal display (LCD) or oscilloscope image. Some TDRs store images to allow an operator to compare the initial trace with another trace made after making a repair and to print both traces as a permanent record. (See Figure 10 on page 32.)

Sample waveforms

Sample TDR waveforms show the operator what to expect on the display. For example, Figures 1-10 show:

- (1) a properly terminated cable.
- (2) an open cable.
- (3) a shorted cable.
- (4) a partial open.
- (5) a partial short.

A good approach is to obtain and read the TDR instruction manual to become familiar with the specific unit being used.

- (6) a water-soaked cable.
- (7) a high-resistance joint or splice.
- (8) an antenna connected to cable.
- (9) RF energy on cable (use filter).
- (10) dual trace, with both storage and live traces displayed.

The 10 waveforms show only a

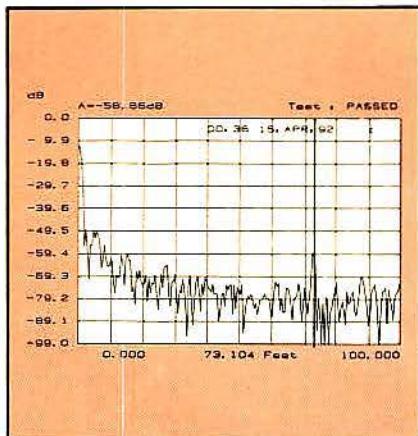


Figure 14. A typical plot of distance to fault of a transmission line.

small example of the many types an operator is likely to see.

Nevertheless, they represent the most common waveforms found in coaxial cable testing. The operator should become acquainted with the TDR and its various displays by experimenting with a variety of cables under simulated conditions. A good approach is to obtain and read the TDR instruction manual to become familiar with the specific unit being used.

FDR

A frequency-domain reflectometer works on the basis of a frequency-sweep generator: A sample of sweep generator signal is used to calibrate a scalar analyzer or tracking generator.

A directional coupler separates the

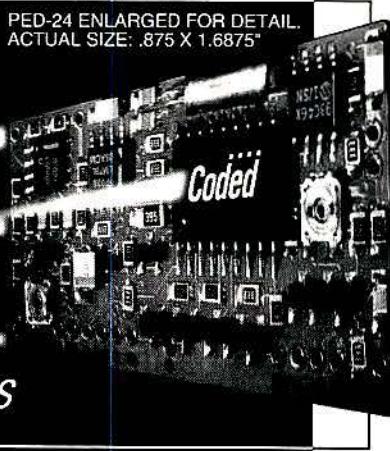
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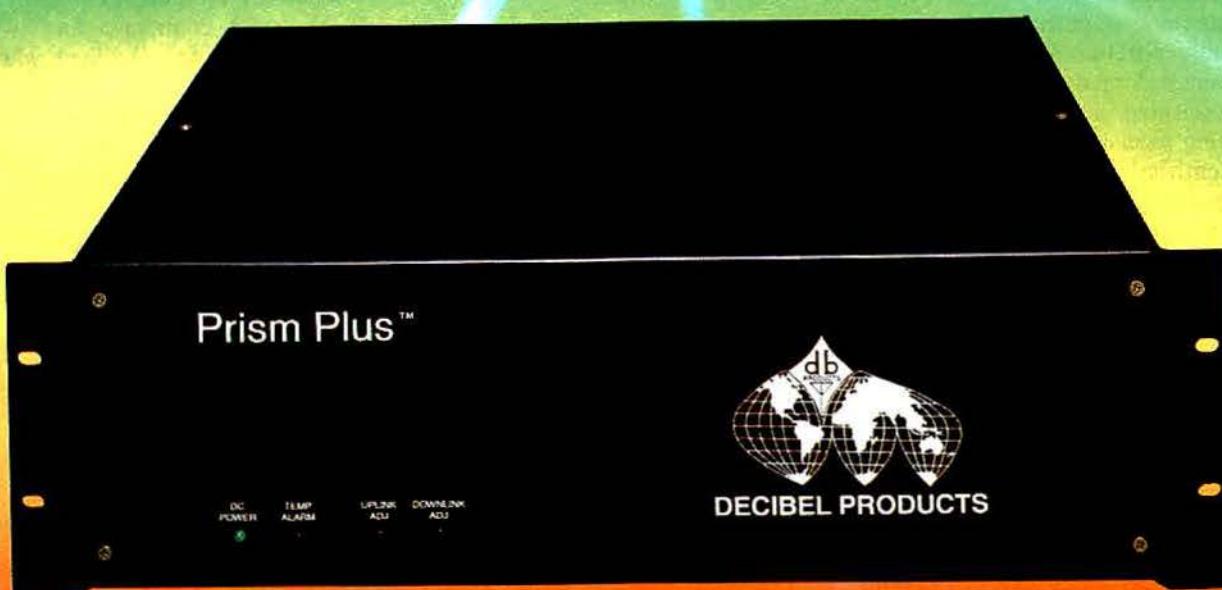
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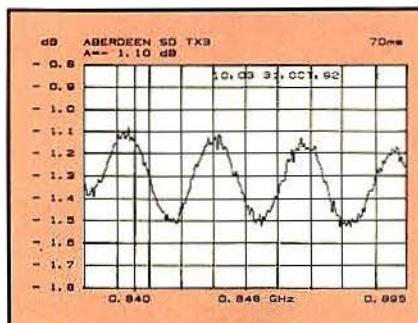


Figure 15. A typical plot of transmission line return loss.

outgoing sweep from the reflected sweep. A properly designed FDR with scalar data can provide the following information:

- (1) spectrum analysis.
- (2) insertion loss.
- (3) fault location.
- (4) antenna resonance.
- (5) return loss (voltage standing wave ratio or VSWR).
- (6) group delay.

The most commonly required measurements are spectrum analysis, insertion loss, fault location and antenna resonance.

► **Spectrum analysis**—A scalar FDR allows a frequency sweep of a transmission line, an antenna or both to display frequency-related problems in the line or antenna.

Antenna resonance is displayed to determine whether the antenna is defective or tuned to the proper frequency. A predetermined sweep range is selected, and any external signals being received by the antenna can be identified for receive level and frequency.

► **Insertion loss**—Insertion loss can be determined if both ends of a cable are available to measure the cable loss directly at the required operating frequency.

Loss in a jumper cable, connector, duplexer or combiner can be directly measured with the scalar FDR.

► **Fault location**—Although a TDR locates transmission line faults, it cannot measure the fault over a frequency spectrum, only time. (See Figure 11.)

A scalar FDR using the Fourier transform relationship can measure fault location at any predetermined frequency. This capability is extremely important at higher frequencies where

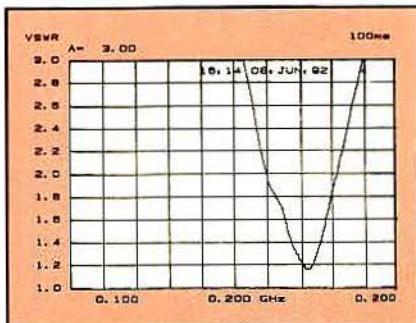


Figure 16. A transmission line VSWR plot.

cable connectors can affect VSWR greatly.

The FDR does not have a blind spot; the TDR is limited by the blind spot.

► **Antenna resonance**—The scalar FDR generates a curve of the frequency sweep and indicates the return

Good engineering practice dictates that repeating the sweeps every year helps to detect deterioration or increased return loss.

loss or VSWR at all sweep frequencies; therefore, the antenna's resonant frequency is plotted, as well as the return loss.

► **Return loss**—Perhaps one of the most important and popular measurements, *return loss*, allows the operator to measure the amount of line loss

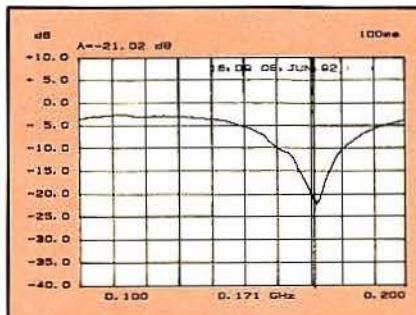


Figure 17. An antenna resonance plot.

directly at any operating frequency.

This loss can be checked against the calculated loss provided by the cable manufacturer. This test determines the cable's condition and measures return loss accurately. The operator must know the operating frequency, cable length and cable velocity of propagation (VOP).

From the amount of return loss, the operator can calculate or directly read the VSWR or the *voltage reflection coefficient* of the cable. The smaller the VSWR reading, the better the cable and load impedances match.

Figures 12-18 show the block diagram of the directional coupler test head for a scalar FDR; the block diagram of the scalar FDR setup for making insertion loss, return loss, VSWR and antenna resonance measurements; and several typical test plots.

Other information

Typically, TDR measurements are used for frequencies as high as 450MHz on coaxial cables, which covers as much as 80% of the applications.

Above 800MHz and at microwave frequencies, the FDR is highly preferred.

A scalar FDR costs \$40,000 to \$60,000, which is a substantial investment for a smaller company. Most companies contract a line sweeping service to check feedlines when they are installed.

Good engineering practice dictates that repeating the sweeps every year helps to detect deterioration or increased return loss. Early detection allows repairs and replacements to be scheduled before a serious loss occurs.

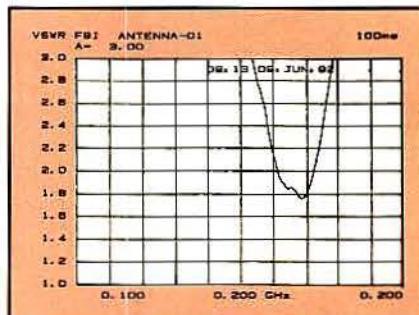


Figure 18. An antenna VSWR plot.



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- DTMF encode and decode
- GE Mark V
- 5/6 tone Sequential
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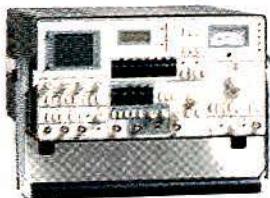
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IMCE/Spring wrap-up

Speakers in the opening session of the mobile communications industry's largest show talked about the converging technologies for personal communications. Here are some of their comments.

Nancy Campbell
Senior Associate Editor

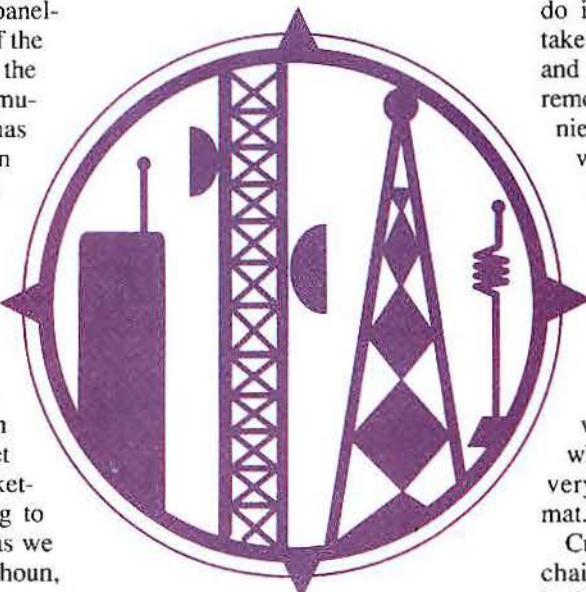
Telecommunications, paging, wireless data, computers—these are converging technologies that will reshape the mobile radio industry and other industries in the future. The five panelists discussed the current status of the technology and equipment and the timetable that the Federal Communications Commission (FCC) has developed at the opening session of the International Mobile Communications Expo/Spring show held in Anaheim, CA, March 23-25.

The current status of personal communications service (PCS) equipment and technology is still unclear. "Almost all of these new ideas are based upon technology that doesn't exist yet or which hasn't reached the marketplace or which is just beginning to reach the marketplace, literally as we sit here today," said George Calhoun, president of PowerSpectrum.

However David Altounian, manager of business development for Motorola Paging and Wireless Data Group, said that he worked with computer and software vendors that are trying to add wireless capabilities to their products.

"I talk to computer vendors on a daily basis at my job and the perception of where wireless really is, to where wireless is, is dramatically different. So what is happening is the computer and software vendors are already putting products out on the marketplace, although they are very embryonic in nature, at a much faster pace than the wireless makers are able to handle."

There are different technologies combining efforts into the personal communications services, and Rakesh Sood, director of marketing of Personal Communications Systems, AT&T Microelectronics, discussed the need for a compliant set of standards for the technology platform. He said there was



a need for a "compliance of standards which are communications standards, not computing standards that are limited to the specific device that you carry around with you. But these are communications standards that will enable people with different devices based on different hardware standards to communicate with each other based on a common set of communications standards."

Sood gave an example of today's wireline telephone system, where different manufacturers' products communicate with each other because they share a standard of technology.

The regulatory standards that will be

established for PCS have not been clearly defined. Ralph Haller, chief of the FCC's Private Radio Bureau, mentioned his philosophy "that the government that tries to regulate too much is going to thwart the growth of the industry."

Haller continued, "What we need to do is, from a regulatory standpoint, take down the barriers to innovation and take down the barriers that might remove profit motives for the companies. I feel very strongly that the services that are going to be provided in the future will be provided or should be provided based on consumer demand."

"I think there is a danger in part of regulators to say that the public needs this service or they don't need that service, and I think if we do that, frankly, we will really stifle the growth of what I think is going to be a very exciting communications format."

Currently the FCC has an interim chairman, and President Clinton is looking for individuals to fill two vacant commission seats, so a timetable for adopting standards and regulations has not been established. Haller said, "I would hesitate to give you a specific time. As you know, we are, as an agency, in transition. It is difficult for me to predict whether the commission is going to want to act on such an important decision prior to the time that we have a full commission. It is a major issue of the commission; it is certainly not a back burner issue."

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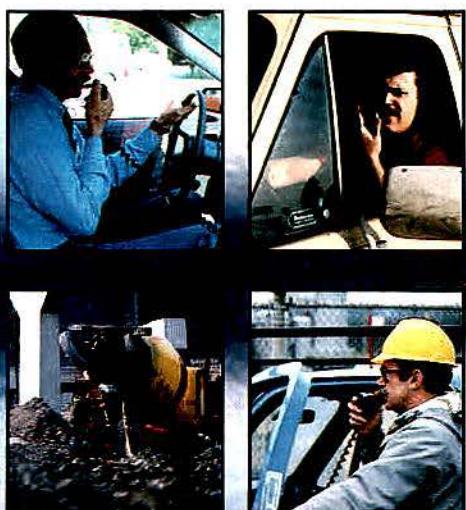
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Technically speaking

(continued from page 8)

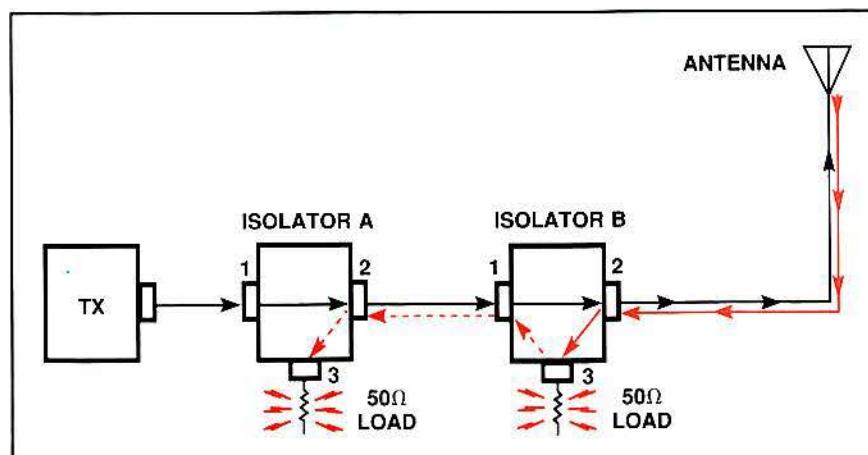


Figure 3. Two isolators can be connected in cascade to provide even greater isolation. The load resistor connected to port 3 of isolator B dissipates most of the reflected power, shown in red.

port 2 directly to port 3 and dissipated as heat by the dummy load at port 3. Any power reflected by the dummy load at port 3 is routed back to port 1 (broken red line) and thus back into the transmitter.

On the other hand, the RF level represented by the broken red line going to port 1 normally is much smaller than the RF level dissipated by the dummy load at port 3. Thus, most of the reflected power is dissipated as heat in

the dummy load and not returned to the transmitter through port 1.

Single-section vs. dual-section

When more isolation is desired than a single-section isolator can provide, two or more isolators can be connected in cascade to achieve the desired isolation.

Dual-section and even triple-section isolators are available from most isolator manufacturers. There are advantages and disadvantages to cascading single-section isolators or using dual-section or triple-section isolators or a combination.

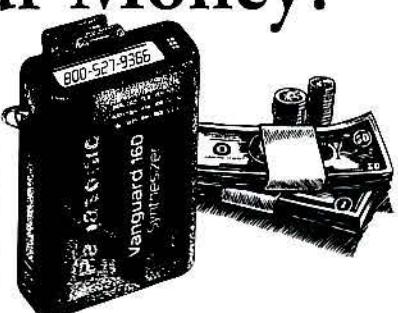
Figure 3 to the left shows how two separate single-section isolators may be connected in cascade to provide additional isolation. If both isolators are identical, the isolation provided by two connected in cascade is twice that of one alone. At the same time, the insertion loss is twice (or more) that of a single section.

If there is a severe impedance mismatch at port 2 of isolator B, most of

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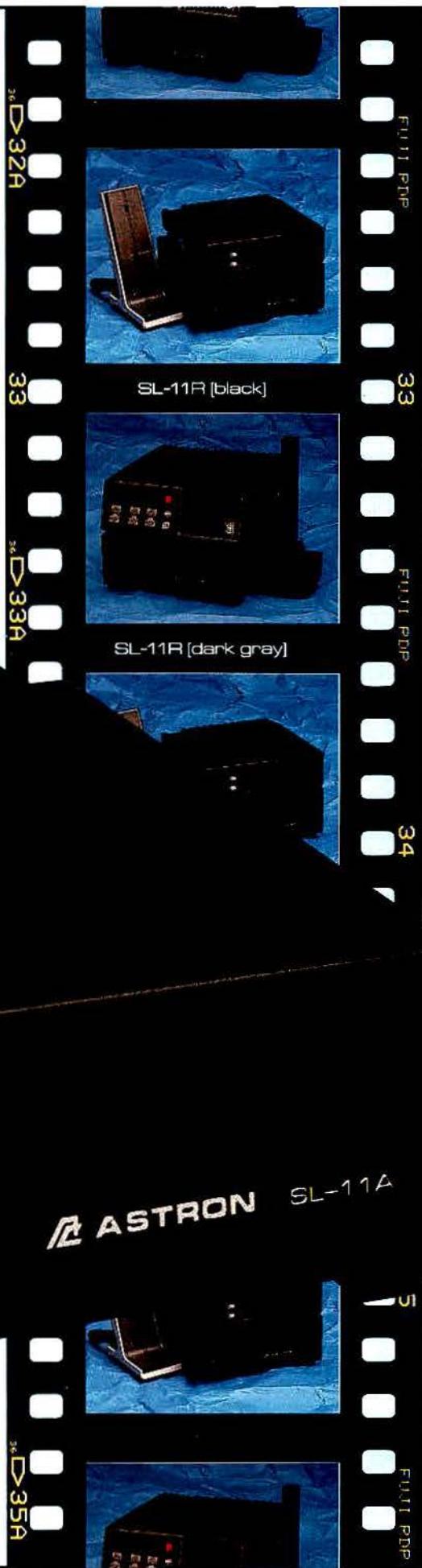
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the reflected power is directed into the load at port 3 of isolator B and is dissipated as heat. Because the load at port 3 of isolator B should provide a good impedance match, little power is reflected back into port 3 of isolator B and on to isolator A.

Nevertheless, any reflected power entering isolator A from isolator B is directed to the load at port 3 of isolator

A. The power dissipation of the load at port 3 of isolator A is small because the brunt of the reflected power is taken by the load at isolator B. Thus, the load connected to isolator A need not be as large as the load connected to isolator B.

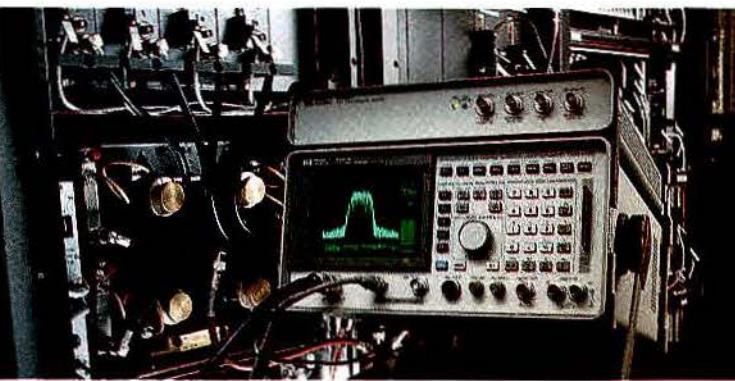
A dual-section isolator can provide the same isolation as two single-section isolators in cascade and cause

less insertion loss. In addition, a dual-section isolator costs less than two single-section isolators. Still, two single-section isolators are not twice as expensive as an equivalent dual-section isolator.

Another advantage of the dual-section isolator is that it is less cumbersome to connect because the interconnecting cable between the output of one isolator and the input of the next is eliminated, moreover, the dual-section isolator requires less space.

One advantage of using two single-section isolators instead of one dual-section isolator is the repair-and-

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A dual-section isolator can provide the same isolation as two single-section isolators in cascade and cause less insertion loss. In addition, a dual-section isolator costs less than two single-section isolators.

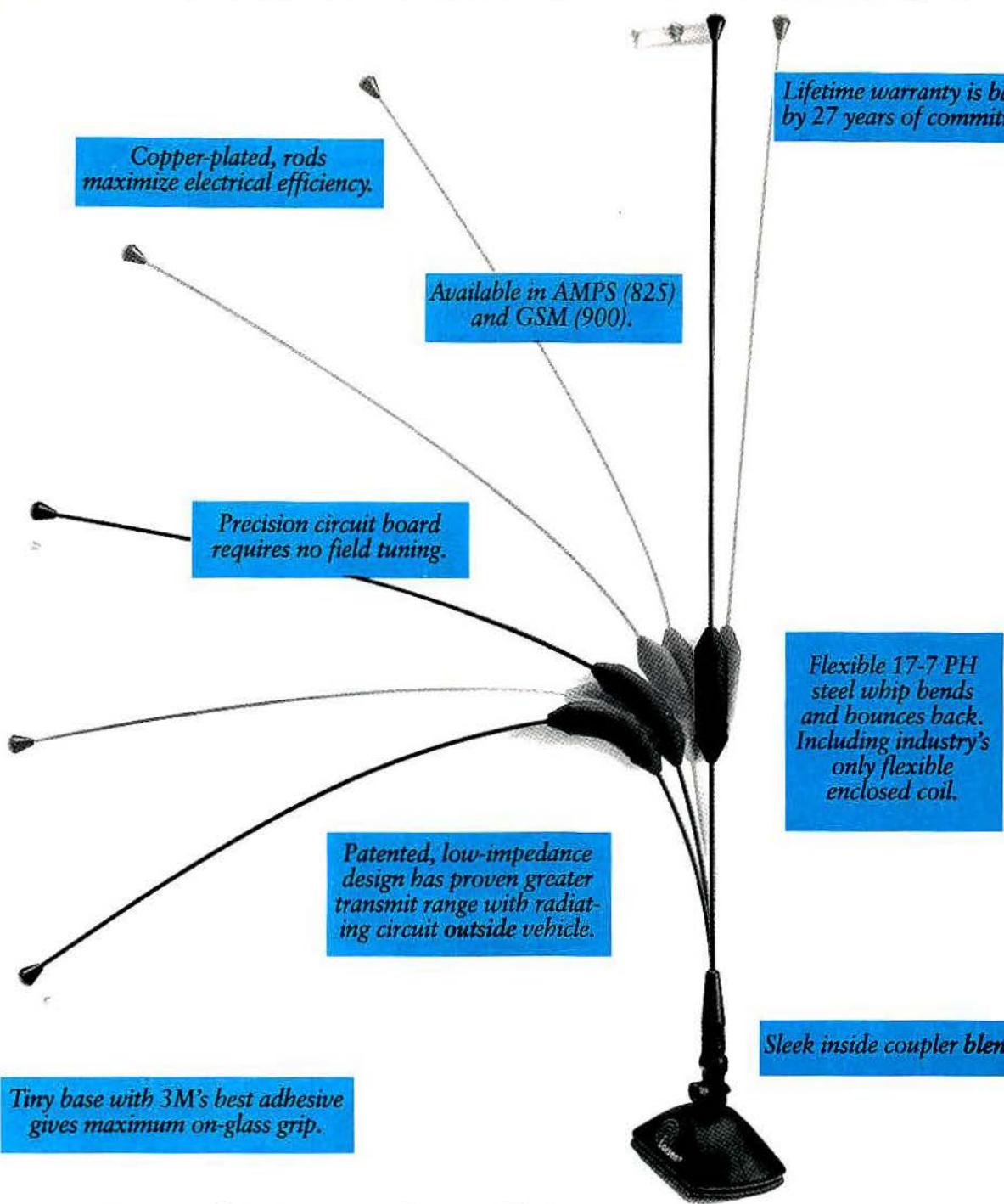
replacement factor. If one section of a dual-section isolator goes bad, the entire isolator must be replaced. Two single-section isolators can be tested and replaced separately, reducing replacement cost.

A further advantage of using two single-section isolators is to provide better dissipation because the heat generated is dissipated over a greater surface area.

Simple mathematical analysis

Refer to Figure 3.

Suppose that the two isolators, A and B, are identical single-section isolators with an isolation of approximately 20dB and an insertion loss of 0.35dB. Assume that the power input from the transmitter to port 1 of isolator A is 100W.



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Further assume that the return loss at the output of isolator B (port 2) is 10dB. According to Table 1 to the right this return loss is equivalent to a VSWR of 1.93:1. The forward power at the output of isolator B (port 2) is 0.7dB below 100W. (This 0.7dB is the combined insertion loss of the two isolators.) This insertion loss reduces the forward power to 85.1W.

Because the return loss is 10dB, the reflected power level is 8.5W at port 2 of isolator B. This reflected power is directed to port 3 of isolator B, where most of it is dissipated in the load.

This is a small loss—approximately 0.35dB—from ports 1 to 3 of isolator B, the same as the insertion loss from ports 1 to 2. This loss reduces the power appearing at port 3 to 0.35dB

Table 1—Return loss vs. VSWR

Return Loss	VSWR
0	∞
1	17.39
2	8.72
3	5.85
4	4.42
5	3.57
6	3.01
7	2.62
8	2.32
9	2.10
10	1.93
11	1.78
12	1.67
13	1.58
14	1.50
15	1.43
16	1.38
17	1.33
18	1.29
19	1.25
20	1.22



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below 8.5W or 7.8W. Assuming the load at port 3 of isolator B presents a good match with a return loss of 20dB (VSWR of 1.22:1), the power reflected back into port 3 is 0.07W or 78mW and is directed on to port 1 of isolator B.

The reflected power appearing at port 1 of isolator B is 0.35dB below 78mW or 72mW and passes on through the interconnecting cable to port 1 of isolator A to port 3 of isolator A. The reflected power appearing at port 3 of isolator A is 0.35dB below 72mW or 66.4mW.

Again, assuming the load at port 3 of isolator A presents a good match with a return loss of 20dB (VSWR of 1.22:1), the power reflected back into port 3 of isolator A is 0.664mW or 664μW.

Thus, at isolator A, a forward power of 100W enters port 1, and a reflected power of 612.6μW leaves port 1. The return loss is $10\log(100/0.000612) = 52.1\text{dB}$ or a VSWR of 1.005:1. This example shows how the isolator maintains a constant impedance match to the transmitter.

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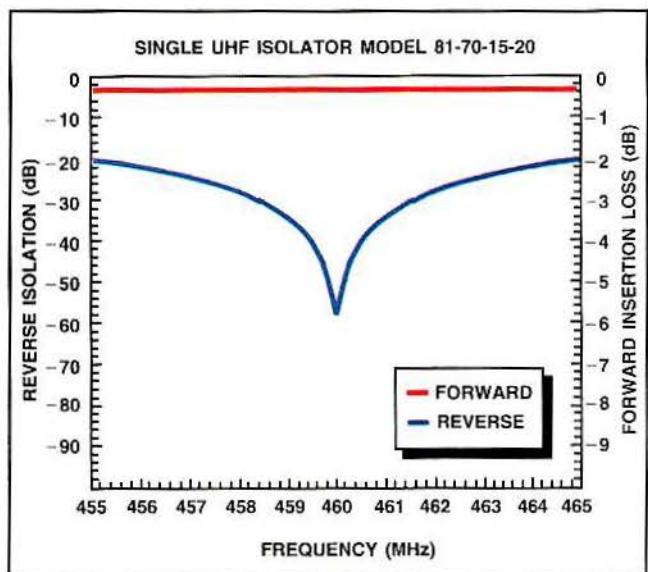


Figure 4. This graph shows both the insertion loss and the isolation with respect to frequency for a single-section isolator. (Courtesy TX RX Systems.)

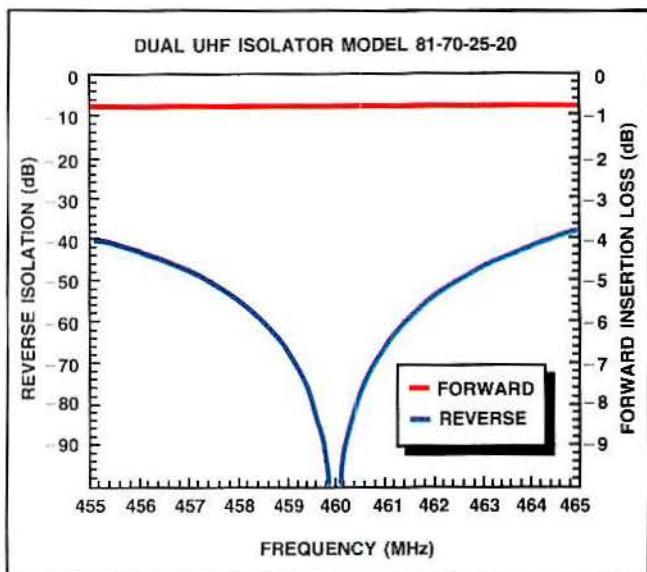


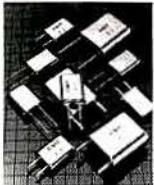
Figure 5. This graph shows the insertion loss and the isolation with respect to frequency for a dual-section isolator. (Courtesy TX RX Systems.)

Notice that the return loss at the transmitter output is 52.1dB while the return loss at the output of port 2 of

isolator B is 10dB. The return loss at the transmitter should equal the *combined* isolation figures of the isolators

plus the return loss at the output port of the final isolator *plus* the *combined* insertion loss figures of the isolators.

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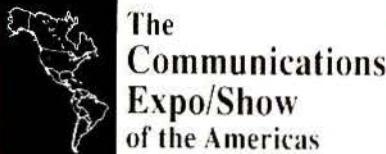
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Technically speaking

In Figure 3, this is $20.7\text{dB} + 20.7\text{dB} + 10\text{dB} + 0.35\text{dB} + 0.35\text{dB} = 52.1\text{dB}$.

The isolation provided by the isolators in the example can be calculated using the formula:

$$\text{Isolation (dB)} = 10 \log(P_2/P_1)$$

where

P_2 = reflected power at port 2

P_1 = reflected power at port 1

In the example, the reflected power at port 2 of isolator B is 8.5W (P_2) and the reflected power at port 1 is 72mW. Substituting into the formula:

$$\begin{aligned}\text{Isolation dB} &= 10 \log(8.5/0.072) \\ &= 10 \log(118.055) \\ &= 20.7\text{dB}\end{aligned}$$

It is important that the load be properly matched to the isolator port. Any power reflected back into port 3 places an additional power dissipation requirement on the isolator.

The same formula can be applied to isolator A in the example, and the isolation figure comes out the same: 20.7dB. Typical isolation figures for single-section units are better than 30dB, so the performance would exceed that of the example.

Figure 4 on page 48 graphs isolation vs. frequency of a typical single-section isolator. The insertion loss vs. frequency also is shown.

Figure 5 on page 48 is a similar graph for a dual-section isolator. No-

tice that the isolation provided by the dual-section isolator is much greater than that provided by the single-section isolator. Notice, too, that the insertion loss of the dual-section isolator is greater.

Heat: The enemy

Heat is the number one enemy of isolators.

As long as isolator temperature is kept within the specified operating range, typically -30°C to $+60^\circ\text{C}$ or -22°F to $+140^\circ\text{F}$, the isolator should perform as specified. When the isolator is operated outside this temperature range, disaster can result. Here are some recommendations for avoiding such a disaster:

(1) Avoid exceeding the specified input power rating.

(2) Use a good-quality dummy load on the termination port.

It is important that the load be properly matched to the isolator port. Any power reflected back into port 3 places an additional power dissipation requirement on the isolator.

Further, the load should have good, thermally efficient radiating fins to radiate the heat instead of conducting it back into the isolator.

(3) Do everything possible to minimize the power reflected back into port 2 from the antenna, feedline and duplexer. Keeping the reflected power low sends less power into the dummy load and reduces the heat generated there.

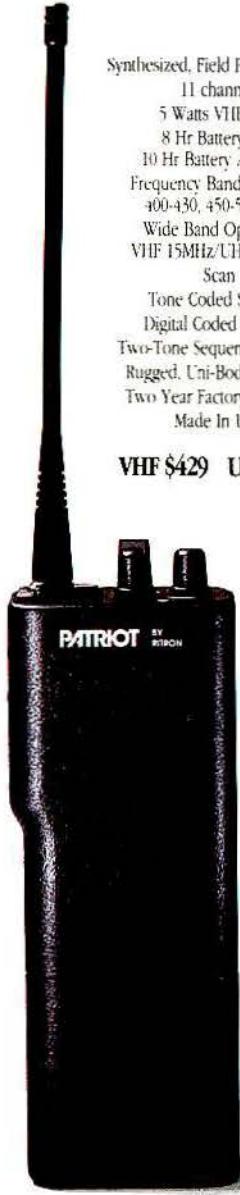
(4) If it is necessary for the dummy load to dissipate much power, then consider physically separating the load from the isolator by using a well-shielded connecting cable. This separation reduces the heat transferred by conduction from the load to the isolator.

(5) Avoid placing the isolator in a high-ambient-temperature location.

If necessary, use fans to force air over the isolator to keep the temperature within safe operating limits.

(6) Use common sense.

Next month, we take a closer look at various isolator specifications and how to operate the devices within safe limits.



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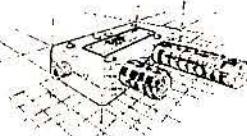
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News

NABER to represent tower owners, site managers in Washington, DC

The National Association of Business and Educational Radio (NABER), an Alexandria, VA-based trade association, held an ad-hoc membership committee meeting in March to discuss the issues affecting tower owners and site managers and their need for representation in Washington, DC. As a result, four committees were formed.

The Forest Service and Bureau of Land Management Committee will focus on issues facing tower owners and site managers that lease federal land. *The FCC and FAA Committee* will focus on issues such as the FCC's tower painting and lighting requirements and fines that may result from noncompliance. *The Environmental Impact Committee* will deal with issues

concerning communications towers and their effect on the surrounding environment.

NABER is organized with membership sections governed by volunteer leadership councils; therefore, an interim committee of volunteers was established to develop the governance structure and policies of the new tower owner and site manager membership section to be presented at its first council meeting at the association's annual Mobile Communications Conference in May. For more information about the tower owners and site managers membership section, call Denise Walter at NABER, 800-759-0300.

Associations team up to provide database service

The American Mobile Telecommunications Association (AMTA) and the Industrial Telecommunications Association (ITA) have teamed up to offer a database service for 220MHz local licenses. The database contains administrative and technical information for tentative selectees and licensees. Data are available by printout or on diskette.

AMTA and ITA also offer 800MHz and

900MHz license data. This information is helpful to 220MHz licensees who want to know what specialized mobile radio (SMR) services are available in their coverage areas. The 800MHz and 900MHz data are available by printout, on diskette, or directly on-line.

For more information on the AMTA and ITA services, call AMTA at 202-331-7773 or ITA at 703-528-5115.

Motorola targets consumers with paging message

Motorola's Americas Paging Products Division in Boynton Beach, FL, started its first national consumer advertising campaign for pagers on April 26. Targeted on women with children; young, mobile

adults; and business people, the campaign is the largest advertising project ever undertaken in the paging industry, according to Robert Pollack, director of marketing for the division's Paging Products Group. The multimillion-dollar national magazine, cable TV and spot TV campaign conveys the message that pagers are for everyone.

Rig Telephone purchases Data-Com, Offshore Telephone Co

Rig Telephones has completed an agreement to purchase the assets of Western Atlas' subsidiaries Data-Com and The Offshore Telephone Company. The new business, Datacom, will continue to supply communications to the petrochemical industry on land, inland waters and offshore. The company intends to expand its data communications, customized alarm systems and SCADA systems sales and rentals to waste-water and water distribution clients. Datacom's headquarters is at 1710 W. Willow St., Scott, LA 70583-8510; 318-234-3438; fax 318-269-1284.

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RCC-PCP difference continues to blur; exclusivity, eligibility barriers may fall

By Robert H. Schwaninger Jr., esq.

The FCC is taking additional steps to blur the distinction between common carriers and private carriers in PR Docket 93-35 (released March 31, 1993).

This *Notice of Proposed Rulemaking* (NPRM) would grant exclusivity to qualified private 900MHz paging carriers. Qualified operators are to be those that have constructed as many as six paging transmitters per market, except in the top three markets where the threshold would be 18 transmitters.

Some questions remain, such as whether to adopt the proposed 70-mile separation for exclusivity; whether loading standards should apply; whether the required transmitters must be of a certain quality and power; and whether frequency coordination would be necessary.

The FCC has this proceeding on a fast track, with comments having been due by May 6, 1993.

At first, the NPRM included a freeze on filing new applications for 900MHz pri-

vate carrier paging (PCP) applications, but industry pressure caused the FCC to lift the freeze.

A few years ago, one might have expected the common carrier community to protest vigorously against exclusive PCP channels, but now, even a cursory review of the FCC licensing records shows that many of the larger, more vocal radio common carriers (RCCs) also hold 900MHz PCP licenses. One can, therefore, expect some, but not great, resistance.

The FCC earlier had blurred the RCC-PCP line in PR Docket No. 93-38 (released March 12, 1993) wherein the agency proposed to lift the restriction on sales to individuals by 900MHz PCP system operators. Leading the effort in support of the proposal are traditional common carriers PageMart, Paging Network and PacTel Paging, demonstrating that, as RCC paging frequencies have become scarce, traditional RCCs are looking at 900MHz PCP spectrum to expand their operations. These RCCs-come-PCP system operators want many of the benefits that traditionally were offered only to RCCs.

Providing paging services to non-eligible individuals has turned many PCP system operators into scofflaws. Because the FCC is not eager to begin examining PCP system operators' files to determine whether service is being provided only to eligible customers, adopting this NPRM would provide relief to both the system operators and to the FCC.

There has been increased interest in the 900MHz PCP channels.

Some operators, anticipating these rulemaking proceedings, filed dozens of license applications in hopes of securing exclusive channels in selected markets. How many will succeed is unknown.

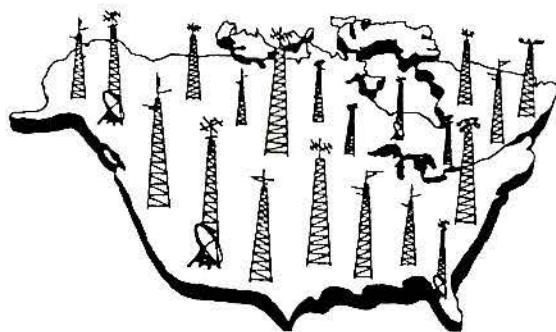
Two elements weigh against attaining exclusivity:

(1) existing, smaller systems, which the NPRM proposes to grandfather.

(2) the lifting of the freeze, which allows applicants to request licenses for frequencies that might have been deemed

Schwaninger, *MRT's* regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC.

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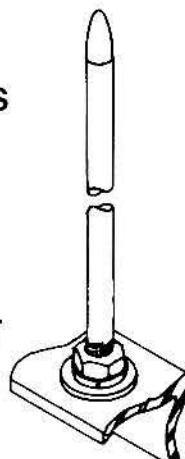
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Regulating technology

exclusive if the freeze had been left in place.

The blurring of the RCC-PCP line, as demonstrated in the FCC's most recent proposals, may foreshadow things to come, such as the creation of a Land Mobile Radio Service for all paging and two-way commercial operations. It is too early for dependable predictions, but these NPRMs appear to be setting the stage.

Enforcement

The FCC Field Operations Bureau (FOB) is getting its feet wet in the area of enforcing co-channel transmitter operating regulations.

FCC actions have shifted the primary responsibility for enforcing Private Radio Bureau's (PRB) sharing rules from the PRB to the FOB. Early indications are promising for victims and unsettling for abusive operators.

Two cases before the FOB raise the question of whether it is permissible for RCCs to rebroadcast their paging traffic over PCP facilities. This technique often is used by RCCs to grab airtime from competing PCPs.

Although the rules suggest that this type of operation is forbidden, the FCC is con-

sidering the question in the two cases and in response to a request for advisory opinion submitted to the PRB by PCPs who want protection.

Meanwhile, it appears that the FOB is considering seriously complaints regarding co-channel interference.

The bureau finally appears to recognize the fact that a victimized operator is not in a good position to provide much cooperation with a party intentionally causing interference. (Cooperation is required by FCC rule Section 90.173(b).) In such interference cases, the FOB appears to be ready to enforce its rules against the interfering operator.

One note of caution, though, has to do with the FOB's speed of service.

Despite its diligence, the FOB still is woefully underfunded and must prioritize its work extensively; therefore, co-channel interference complaints still may languish for months before regulatory relief can be provided.

Critical mass

Speaking of service speed, it appears as though the PRB Licensing Division is headed toward critical mass.

A document released April 1, 1993,

reads that the division is processing applications for facilities operating below 450MHz in about 45 days, and SMR base station applications endure a processing time of about 175 days. These numbers shot up rapidly after the division accepted the job of processing Point-To-Point Microwave Service and Auxiliary Broadcast Service applications.

The FCC Gettysburg, PA, office staff is trying to cope with the increased workload, but the budget only provides for so many employees and so much equipment. Add to that the woeful state in which the Point-To-Point Microwave Service applications arrived (two years behind in processing already), and the picture is far from hopeful.

So, if applicants are wondering whatever happened to applications sent in more than a month ago, they would be well advised to (a) learn patience, (b) do not request application processing status information for at least 60 days and (c) rely on instant licensing whenever possible. Representatives in the FCC Consumer Assistance Branch can only say "We're doing the best we can," so many times.



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56 Mobile Radio Technology June 1993



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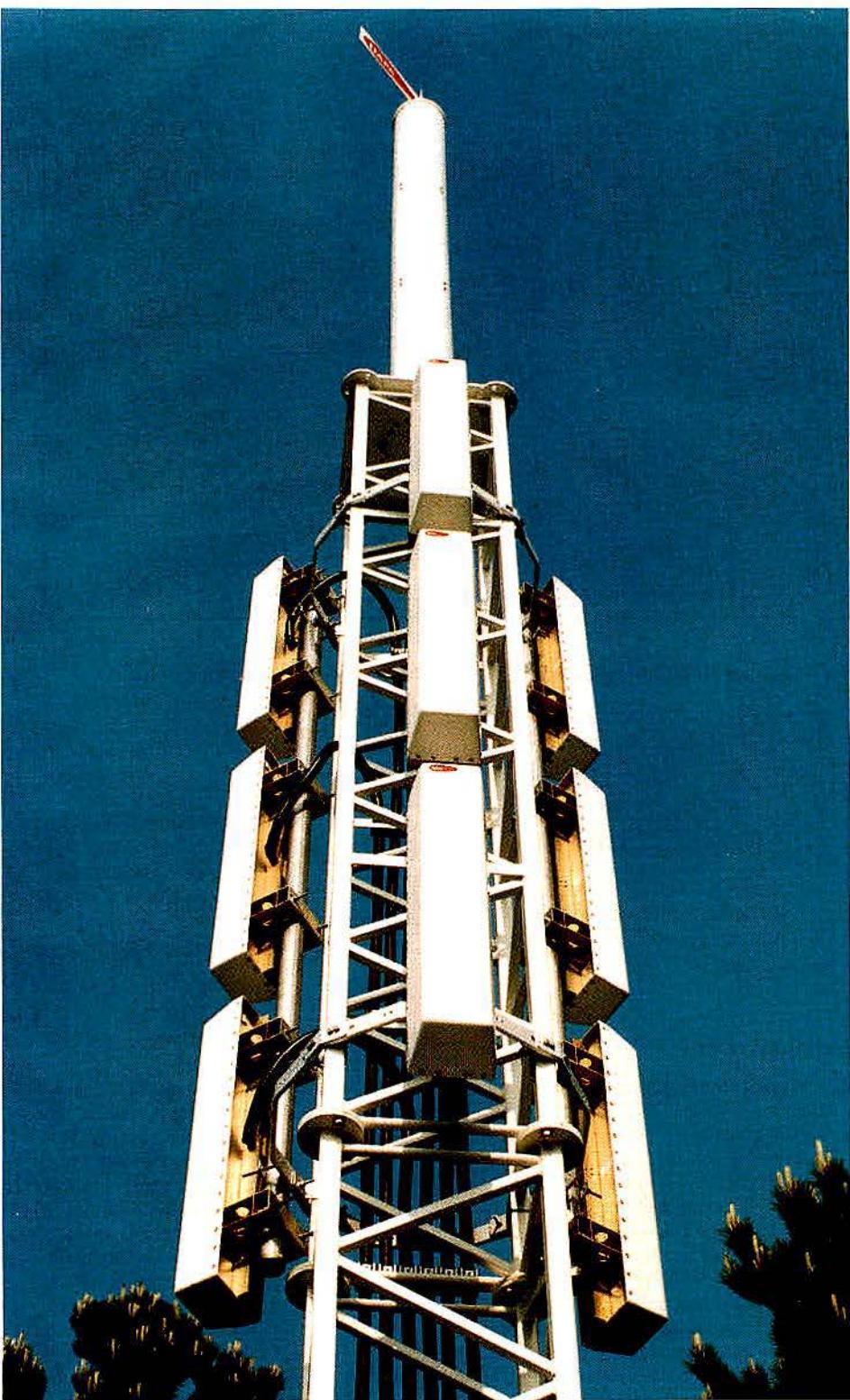
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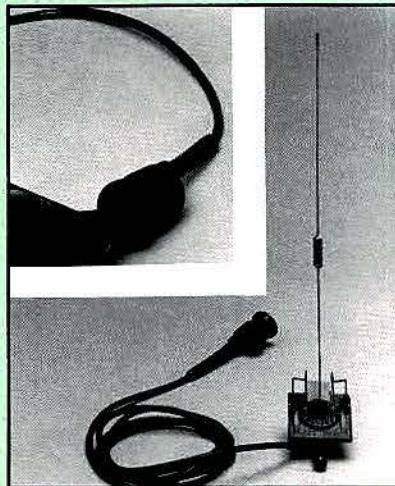
Readers' choice

Of all the new products and services in the October 1992 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Clip-on antenna to improve vehicular hand-held reception

The clip-on coupler antenna from **Mobile Mark** works with the Motorola MicroTAC cellular hand-held for better in-vehicle performance. The antenna slides on and off a vehicle door's window, and the whip is outside the car for better reception.

Circle (500) on Fast Fact Card



Mobile data system holds additional 64 messages in common queue

The Data Messenger System from Selectone sends as many as eight messages of 140 characters each (7 lines by 20 characters) to every mobile, and an additional 64 messages can be stored in a common queue. The mobile can send as many as eight user-defined status reports to the base station with the push of a button. As many as 32 mobile units can be configured in a system. The Data Messenger System

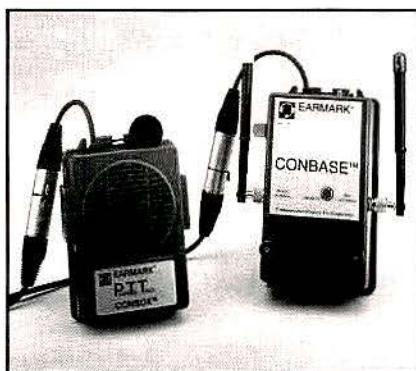
Circle (350) on Fast Fact Card



includes ST-1000 mobile data terminal, ST-1010 base station unit, software, cables and mounting hardware.

Circle (351) on Fast Fact Card

Headset system suits confined space communications



Circle (352) on Fast Fact Card

Conkit from **Earmark** operates in combination with the company's headset and belt-pak radios. It is engineered to solve confined space communications problems. The Conbase, a portable repeating base station is positioned inside the confined space, and the Conbox is outside the confined space for the attendant. With the Conbase inside the confined space, there is no need for the radio signal to penetrate thick metal tanks and reinforced concrete. All the radio transmission and reception takes place at relatively short range, inside the confined space.

Circle (353) on Fast Fact Card

Tower light monitor system sends data to pagers, PCs

The ProTekTor control system from **PageTek** features two analog inputs, four digital inputs and four relay driver outputs for monitor and control of tower lights, as well as other communications equipment. The unit provides alert calls to pagers, people and computers.

Circle (501) on Fast Fact Card

Software analyzes RF site interference

The ComSitePlus integrated software from **Douglas Integrated Software** combines the DesensePlus and IntermodPlus programs into a communications site RF interference analysis package. The software determines isolation values required to prevent no more than 1dB degradation of the receiver's 12dB SINAD sensitivity due to transmitter noise and receiver desensitization.

Circle (502) on Fast Fact Card

Solar electric modules boast 27W, 53W of power

Photocomm's PowerValue solar electric product line uses a thin-film solar cell technology developed by Advanced Photovoltaic Systems. The PowerValue solar electric modules feature power ratings of 27W and 53W, rugged aluminum framing, double-glass laminate construction, a polycarbonate junction box and a 12-year power output warranty.

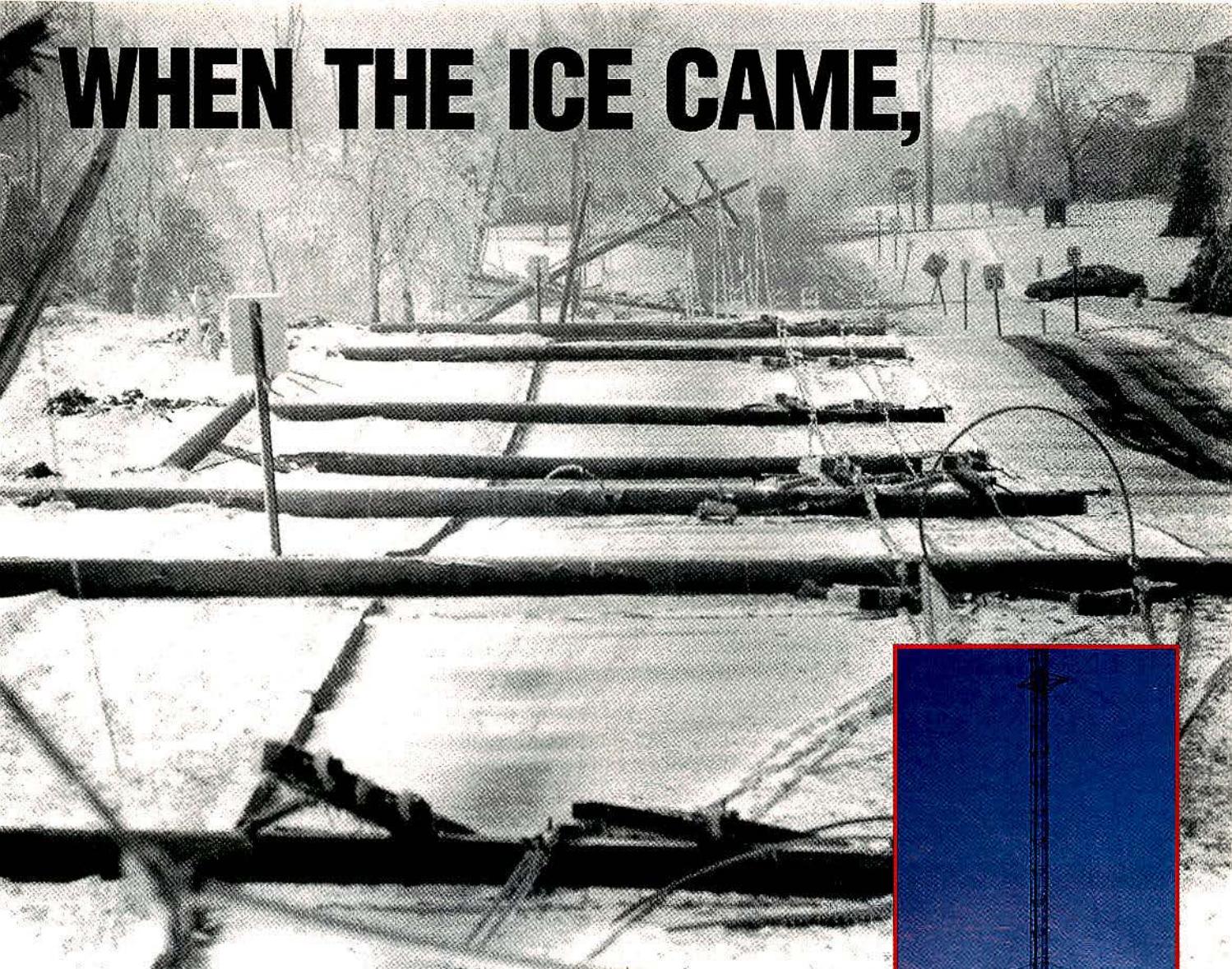
Circle (351) on Fast Fact Card

Battery conditioner senses defective battery cells

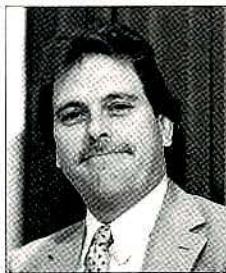
The Rapid Battery Charger and Conditioner from **Advanced Fox Antenna** discharges the remaining capacity of the battery and then automatically converts to the charge cycle. When the battery reaches 60% charge, the user is alerted by flashing red and green LEDs and a 2-minute whistle. If the user fails to remove the battery, the charger reverts to a trickle charge for the final 20% of the charging capacity. The conditioner's self-protecting circuitry senses defective battery cells and does not initiate the charge cycle.

Circle (353) on Fast Fact Card

WHEN THE ICE CAME,



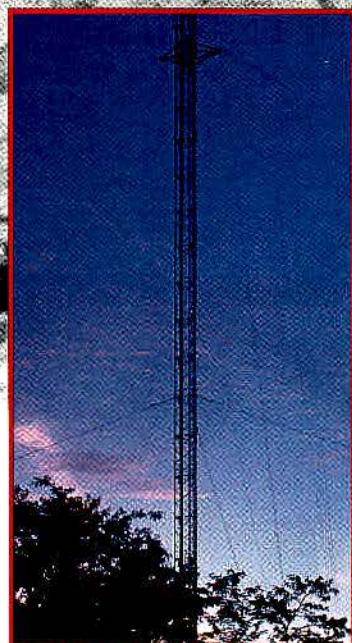
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Dave Turner
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New products

Comm equipment shelter is lightweight, easily transportable

FWT's aggregate exterior communications equipment shelter weighs one-third less than concrete shelters. The aggregate shelters are easily transportable and have lower transportation handling costs.

Circle (354) on Fast Fact Card

Radios offer 25 hours of battery life



The 1.5W EPH VHF portable series covers 148MHz to 174MHz with numeric and alphanumeric keyboards. The Bendix/King radios may be programmed to operate on any VHF frequency in the range without degradation in specification. Battery life for the EPH series is 12 hours with an LAA 0121 NiCd battery, and battery life is 25 hours with the large LAA 0125 NiCd battery.

Circle (356) on Fast Fact Card

Combiner retunes automatically to frequency

The AutoCell autotune cellular transmitter combiners use the ceramic resonators from Antenna Specialists and technology patented by **Decibel Products' Sentry** 8000 remote site monitors to speed up tuning and provide automatic frequency re-allocation between calls. Model ATG7020

is available in a 4-channel configuration that can be phased with additional 4-channel units as many as 24 channels. To correct any drift, the AutoCell makes small adjustments and periodically retunes to frequency automatically.

Circle (355) on Fast Fact Card

Interconnect features voice delay



The CS-900 features a $\frac{1}{2}$ -second electronic voice delay (EVD), built-in programming keyboard with digital display, 90 memory speed-dialer and call progress tone detection. The interconnect unit from **Connect Systems** is voice activated and can be used simplex or through any remotely located repeater. The EVD prevents syllable and word clipping normally associated with low-cost interconnects.

Circle (357) on Fast Fact Card

Battery charger with adapter cups fits various battery models

With one charger and a simple change of an adapter cup, the Master-Charger I can charge from a Motorola to a GE to an Icom to a Yaesu radio by plugging in the appropriate adapter cup. The charger from **W & W Associates** can charge any battery from 6V to 13.2V. The unit can be used from an automobile cigarette lighter receptacle or from a wall outlet.

Circle (358) on Fast Fact Card

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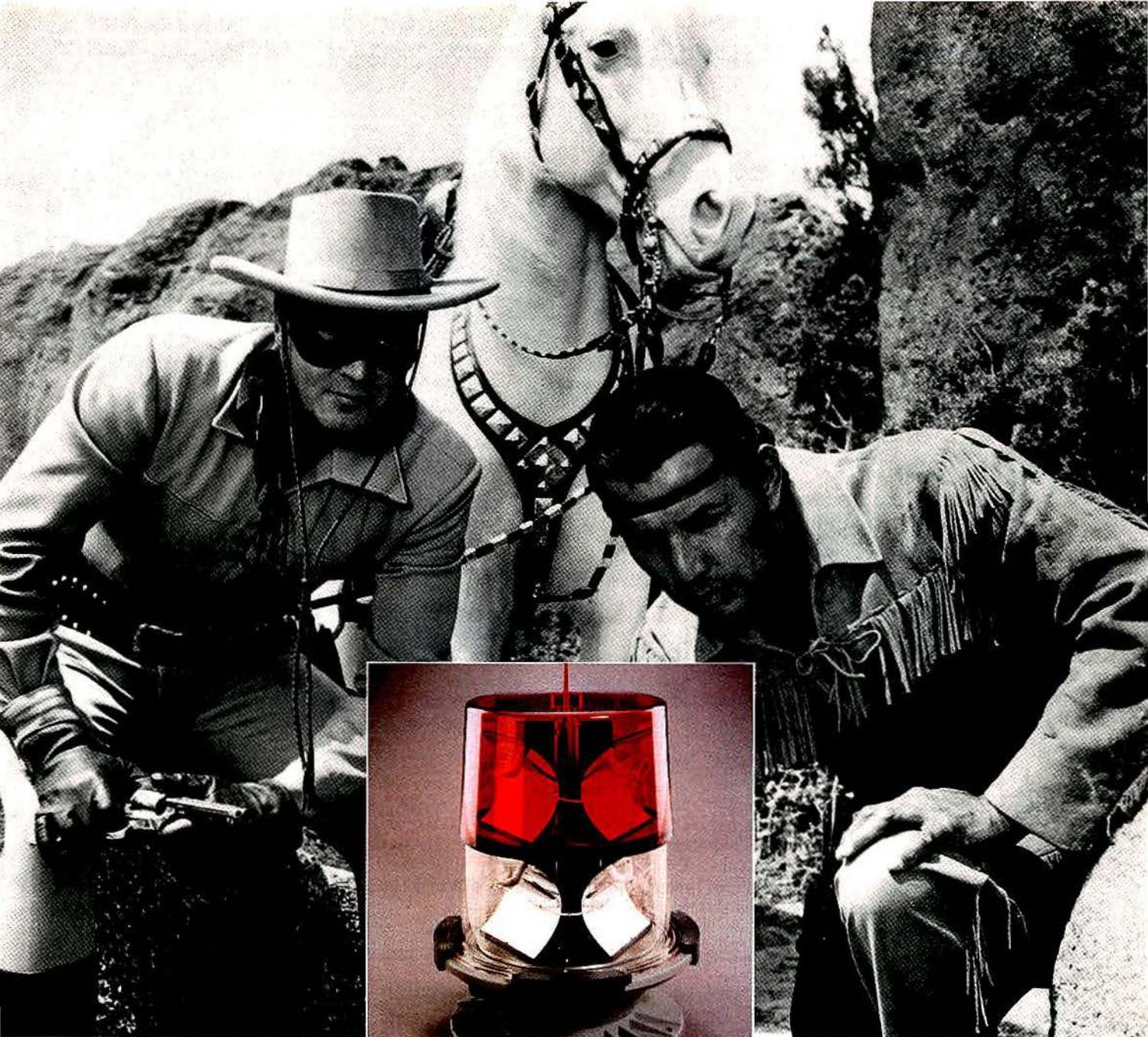
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Circle (61) on Fast Fact Card



One look and you know it's the perfect partnership.

The FlashGuard 3000 is the first to combine FAA/ETL-certified red and white beacons in a single unit. For a lot of tower owners and installers, that's a powerful combination.

For one thing, the 23" high FlashGuard 3000 costs less than separate beacons. Less to install. Less to operate (it uses 1/8th the power of conventional units). And less to maintain.



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Circle (62) on Fast Fact Card

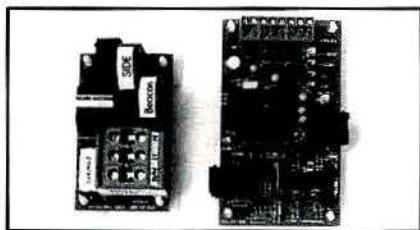
New products

Software calculates volume of ground enhancement material

A software program from **Erico, Electrical Products Group** calculates the required volume of Cadweld Gem ground enhancement material and determines the resulting resistance to ground. The program contains general information on Gem and instructions on using the material with vertical and horizontal grounding electrodes. The equations are based on IEEE Standard 80.

Circle (359) on Fast Fact Card

Tower beacon sensor calibrates automatically



The SLS-1 is a tower lighting alarm sensor for standard incandescent lights. A two-circuit board layout reduces installation time and allows ease of installation when the lighting control box is located outside the building or on the tower. The sensor from **TowerWatch** senses major and minor light failure, senses shorted bulbs and checks ac line voltage. The SLS-1 calibrates to the tower's beacons and obstruction lights with the simple push of a button.

Circle (360) on Fast Fact Card

Power inverters feature true sine wave output



The SI series of power inverters from **Exceltech** produce true sine wave output. Power ranges from 250W to 5,000W at 155Vac or 230Vac output. The power inverters can power non-linear, electronic or highly reactive loads.

Circle (361) on Fast Fact Card

Interface retrofits Tandy receivers

The HB-232 scanner and computer interface retrofits to Tandy/Realistic PRO-2004, PRO-2005 and PRO-2006 programmable VHF and UHF scanning receivers. The interface offers two-way communications and control of the receiver by a 640k IBM compatible with a 9,600 baud serial port. The HB-232 from **Comtronics Engineering** allows local, remote and automated control of all the scanner's keyboard functions.

Circle (362) on Fast Fact Card

Station identifier allows automatic Morse code ID

The **Racom** 1402 switch programmable automatic Morse code station identifier allows for automatic Morse code identification of repeaters and base stations. Call signs and all operating conditions are programmed with an on-board DIP switch or an IBM PC-compatible computer. Features include sine wave output, system monitors, test switch, monitor speaker, 19" rack-mount and relay contacts.

Circle (363) on Fast Fact Card

VHF FM monitor receiver covers 140MHz-170MHz

The AR-33B is a fully synthesized portable VHF monitor receiver for the 140MHz-170MHz range. Frequencies are selected with a thumbwheel switch, and two channels may be quickly recalled from memory through a single switch. The radio from **Communications Specialists** measures 5.12" x 2.45" x 1.02" and weighs 7 ounces. A rubber-flex antenna, earphone, BNC-to-SMA adapter and two AA batteries come with the receiver.

Circle (364) on Fast Fact Card

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Circle (63) on Fast Fact Card

Antenna offers 3 bands in 1



The CMT-3 tri-band power antenna from **Yokowo America** integrates AM, FM and cellular bands into one antenna with transmission and reception characteristics equal to or better than stand-alone cellular antennas. The CMT-3 is a 3dB collinear, omnidirectional antenna that provides 6W for cellular transmission. Unlike the conventional glass-mount antenna, the CMT-3 replaces the factory-installed radio power antenna underneath the car fender, allowing the cellular-enabled antenna to be concealed when not in use.

Circle (365) on Fast Fact Card

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New products

Software offers system predictions on PC

Terrain Analysis Package 2.4 allows the radio engineer to perform the system predictions using a personal computer, rather than relying on outside service bureaus or consultants. The new version from **SoftWright** provides enhanced graphics and support for more than 200 printers, including color printers. The user can customize margins, rotate plots for either landscape or portrait mode, set printer resolution and set different text labels on the plot to different character sizes.

Circle (366) on Fast Fact Card

Radio modem features forward error correction

The RDDR-96 is a rugged 9,600bps radio modem that features forward error correction and multichannel capabilities. The multiprotocol radio modem can operate in a transparent mode for simple point-to-point applications, as well as in a packet-switched mode where multiple radio modems coexist in a network. The 2W RDDR-96 from **Pacific Crest Instruments** has access to 1,600 frequencies in the 450MHz-470MHz band.

Circle (367) on Fast Fact Card



Battery system analyzes as many as six batteries at one time

The Telepower conditioner and analyzer battery maintenance system is available in five models that condition and analyze as many as six NiCd batteries simultaneously. The unit from **JaBro** features voltage, capacity, battery fault and cycle count digitally displayed on the LCD at each battery station.

Circle (368) on Fast Fact Card

Land use, land cover data are available on CD-ROM

The US Geological Survey land use and land cover data are on CD-ROM and are available from **Communications Data Services**. The single-disk set contains data for the contiguous United States, Hawaii, Puerto Rico and the Virgin Islands. The data are compatible with Unix and MS-DOS operating systems.

Circle (369) on Fast Fact Card

System supports 32 TNPP links

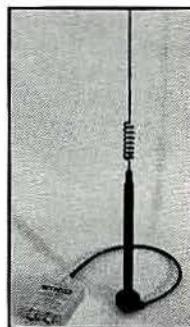
The Advantage TNPP Hub is a high throughput, high capacity network control and traffic accountability system for radiopaging networks. The TNPP Hub may be used as a gateway between networks, as a centralized point in a TNPP network or as a node on a network. The system from **Real Time Strategies** supports as many as 32 simultaneous TNPP links operating at varying speeds as fast as 19.2Kb per second.

Circle (370) on Fast Fact Card

Cellular look-alike antennas are dualband, broadband

The Sti-Co EF-150/450 looks like an ordinary elevated-feed style cellular antenna, but it covers the 24MHz bandwidth in VHF and 20MHz bandwidth in UHF. The EF-450/800 also looks like an elevated-feed style cellular antenna; nevertheless, it covers the 15MHz bandwidth in UHF and 60MHz in cellular. The disguised cellular look-alike antennas are available in roof or trunk-lip mounts.

Circle (371) on Fast Fact Card

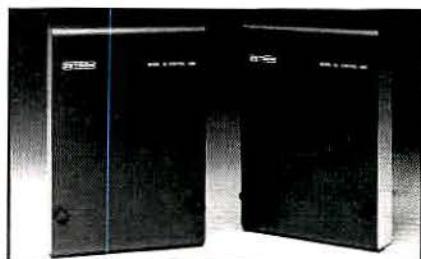


Trunking system boasts automatic site registration, deregistration

The SmartZone system from **Motorola** provides trunked radio communications over large geographic areas plus roaming capability for voice and data systems and efficient use of channels. Two additional features are automatic site registration and deregistration. The automatic site registration allows users to roam from site to site without operator intervention. Deregistration ensures that users are logged off channels if they have moved to a different site, turned off the radio or discontinued using the system.

Circle (372) on Fast Fact Card

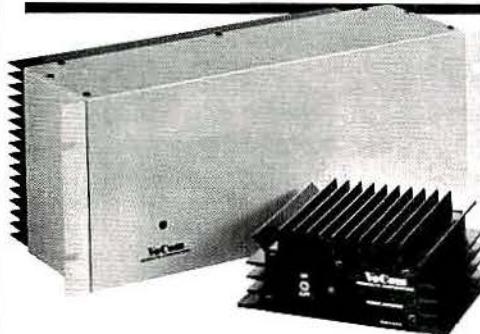
Control link sends as many as 65,000 pulses in 0.3 seconds



The 18/18+ control link can count and store as many as 65,000 pulses and then send the information in a single data burst that lasts less than 0.3 seconds to another control link. The control link from **Zetron** can be programmed by the user to send the pulse count after a specific number of pulses or time duration. The receiving control link will output the pulses at a rate selected by the user.

Circle (373) on Fast Fact Card

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New products

Yagis feature gold-anodized 6061-T6 seamless aluminum

The MYG-8066ED series of welded construction yagi antennas are constructed of gold-anodized 6061-T6 seamless aluminum and feature 360° welds surrounding the $\frac{1}{8}$ " solid elements and connector block assemblies. The antennas from **Maxrad** are constructed with a solid aluminum mounting block, stainless-steel hardware and are fitted with a gold-plated connector.

Circle (374) on Fast Fact Card

Pager offers audio clarity

The VIP III Monitor pager from **Reach Electronics** offers loud, clear audio. Other features include tone and voice, tone-squelched and straight monitor modes. The pager operates on NiCd batteries, features Lifeguard battery-saving circuit and comes in highband and lowband configurations.

Circle (376) on Fast Fact Card



Mobile data system includes AVL

An automatic vehicle location (AVL) system is included in the mobile data communications package offered by **PacketCluster Systems**. Each vehicle is equipped with a GPS satellite receiver that calculates vehicle position within 300 feet. The geographical position is sent with every data transmission.

Circle (378) on Fast Fact Card

Mount fits under the air bag zone



The S2000 ALP from **SMC Electro-Mount** is a low-profile rack-mount system designed to fit under the air bag zone of most cars. The angle of the rack adjusts from vertical to completely horizontal. The S2000 ALP can be mounted to an SMC stack-mount, directly to an SMC saddle plate, or directly to the floor or transmission hump of a vehicle.

Circle (380) on Fast Fact Card

Spectrum analyzer features band, sideband analysis



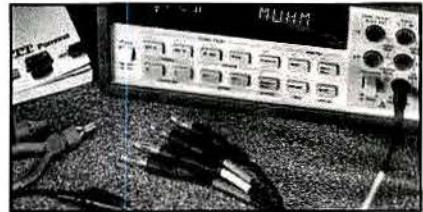
The SR770 spectrum analyzer offers 90dB range and spans from 191MHz to

Circle (375) on Fast Fact Card

100KHz. Accurate frequency response measurements over the entire 100KHz bandwidth are generated with 0.05dB precision. The analyzer from **Stanford Research Systems** measures 17" x 6.25" x 16.5". Standard features include THD, $\frac{1}{3}$ octave, band and sideband analysis, go/no go testing, selectable window functions and post acquisition math.

Kelvin clip test set provides high-precision resistance measurement

Model 5940 Kelvin Clip test lead set from **ITT Pomona** provides four-lead measurement plus a fifth grounding or guarding lead. An insulated minigator ground clip and four-lead set are bundled in a 24" long sheathed cable assembly with single gold-plated banana plugs for DMM connections. Rating is 50V, 5A maximum.



Circle (377) on Fast Fact Card

Dispatch console offers shared status with parallel console



Circle (379) on Fast Fact Card

Model 4010 radio dispatch console has the capability to share status signals with a second parallel console. This allows the two consoles to control the same radio base stations, and when an operator changes the frequency of the base station, the change is reflected on the parallel console as well. The unit from **Zetron** interfaces directly to the radio transceivers and telephone lines to be controlled. The 4010 allows the operator to control two to 12 radio channels and as many as two telephone lines.

Portable, compact radio comes with crystal pair

The Utili-Com UC2200 portable is a 2W, two-channel VHF radio from **Relm Communications**. The radio features an antenna, battery, battery charger and a pair of crystals for one of three VHF frequencies—151.625MHz, 154.570MHz or 154.600MHz. The unit measures 5.75" x 2.25" x 1.25" with the battery attached. Other options include drop-in chargers for rapid or trickle charging, a leather case with swivel belt loop and a speaker-microphone.



Circle (381) on Fast Fact Card

Ear-Mike measures 1 1/2" x 1" x 1/2"



Designed for covert communications, the EM-300 is the smallest Ear-Mike from **Telex Communications**. It measures 1 1/2" long, 1" wide and 1/2" thick. The EM-300 derives power from the portable radio, so no battery is required. Other product features include removable PTT and ear cords, so in case of damage, the user can replace the cords instead of the entire unit.

Circle (382) on Fast Fact Card

Multiplex integrates data devices



The MobilMux combines as many as three RS-232 devices into a single port on any Dataradio vehicle information series (VIS) mobile radio modem. The unit from **Dataradio** measures 7.5" long x 5.7" wide x 1.5" high and is housed in a rugged aluminum case. The standard configuration provides data ports for a terminal or PC, a serial mobile printer and an AVL device. Each port can be addressed locally or via the RF network using Dataradio multiplex protocol (DMP).

Circle (383) on Fast Fact Card

Charger/conditioner recharges NiCd, NMH batteries

The Quick Charger/Conditioner series of combination battery chargers and conditioners includes models that charge NiCd and nickel-metal hydride (NMH) rechargeable batteries. The units from **Ora Electronics** recharge battery packs in about 10% of the time it takes to charge batteries with a conventional trickle charger. The units will recharge NiCd and NMH batteries used in Audiovox Minivox MVX750, Motorola 8000 and 9000 series, Motorola MicroTAC and Panasonic HH900/EB-H50 portable cellular telephones.

Circle (384) on Fast Fact Card



Test set systems include a built-in computer for base station control

The HP 8921A cell-site test set and HP 8921D dual-mode cell-site test system from **Hewlett Packard** include a built-in computer for controlling the base station. The test sets also provide users with customized automated maintenance procedures based on the manufacturer's recommendations. The HP 8921A tests cell sites of AMPS and NAMPS cellular systems using HP 11807B software. The software displays set-up diagrams, checks against the manufacturer's specifications, displays tuning diagrams when necessary and prints results for maintenance logs. The HP

Circle (385) on Fast Fact Card



8921D combines with the HP 8921A with the bolt-on HP 83201A dual-mode cellular adapter, which allows the user to perform complete parametric testing on TDMA dual-mode digital cellular equipment.

Circle (386) on Fast Fact Card

Radio communications products offer convenience, flexibility

TSR Technologies offers five radio communications products: Cellpost, Pagepost, Navtracker, Powertracker and Datablaster.

Cellpost and Pagepost are software products that provide instant access to wireless traffic that often is difficult to obtain from a cellular or paging switch. Telephone or paging calling patterns, most active users, signal level at handoff and paging statistics can be sorted from real-time "off-the-air" measurements using TSR's receiver products.

The Navtracker is a turnkey global positioning system that works with Cellscope and Pagetracker to provide real-time position data during measurements. The easy-

to-use menu-driven software provides foolproof operation and data integration.

Developed for trunked radio, cellular telephone and PCN systems, the Powertracker receiver allows customers to develop customized frequency-agile RF measurements at frequencies as high as 2,000MHz.

TSR Technologies has received a development contract with AT&T Bell Laboratories for the Datablaster, a real-time cellular measurement system that records the data sent on any AMPS, NAMPS or TDMA cellular control channel. It will provide a simple means of measuring control channel data to within a thousandth of a second.

Circle (386) on Fast Fact Card

Input, output connectors move to the rear of the unit

Nucomm has an option for its portable transmitters and receivers. Input and output connectors have been moved to the rear of the units, and the monitoring, controls and switching stay on the front. The option is useful when the transmitters or receivers are rack-mounted and the input and output cabling can cause clutter.

Circle (387) on Fast Fact Card

Encryption capabilities added to LTR mobiles, portables

E. F. Johnson has added encryption capabilities to several of the company's LTR trunked radios. The encryption software was created under a development program with Transcrypt, a voice privacy product manufacturer. To eliminate the audio breaks or "holes" inherent in most encryption schemes, LTR encryption uses continuous data synchronization, which results in extremely high recovered audio quality and virtually no loss.

Circle (388) on Fast Fact Card

Cables bend to 1-inch radius

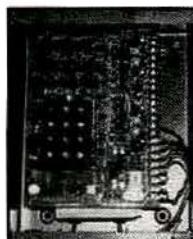
The 1/4" superflexible, 50Ω coaxial cables from **Andrew** are ideal for equipment room jumpers that must connect with high power transmitters. The cables have a 1" minimum bend radius for easy installation and routing in enclosed areas. UL listing and a Type CATVP marking allow them to be used in buildings, plenums and other air-handling spaces. Average power at 1,000MHz is 0.765kW for the jacketed cable ETS1-50T and 0.856kW for the unjacketed cable ETS1-50.

Circle (389) on Fast Fact Card

Site reporter dials three programmed telephone numbers

When connected to a power system, doors or high temperature sensors, the 3059 site management reporter will, upon change of status, start dialing three programmed telephone numbers automatically in sequence to deliver the alarm message. The unit from **Bramco** installs into a telephone jack. Telephone numbers and voice message remain in memory for six weeks without power.

Circle (390) on Fast Fact Card



New products

Telephone interface provides service for as many as 1,100 subscribers

The ST-859 SmarTrunk telephone interface module allows fixed station access to a SmarTrunk system from any standard DTMF telephone. The unit from Selectone provides the interface between an ordinary telephone and any half- or full-duplex ra-

dio. The ST-859 can provide low-cost wireless telephone service for as many as 1,100 subscribers on as many as 16 trunked RF channels. It measures 4 3/4" long x 1 3/4" wide x 1 1/4" high and is designed to mount on the top cover of the host transceiver.

Circle (391) on Fast Fact Card

Earphone slips into ear canal

The Collaret wireless earphone from TEA is funnel-shaped and slips into the ear canal. The portable radio is typically installed in the small of the user's back and is connected to a flat microphone which is pinned under the clothing near the user's collarbone. A small pendant-type press-to-talk switch is located in the user's hand or pocket.

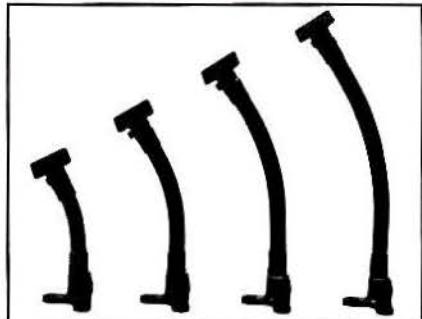
Circle (392) on Fast Fact Card

Recorder offers user-friendly LCD, easy-to-read-menus

The VCG-600 VHS communications recorder records as many as 12 or 24 channels for 27 hours on a single VHS cassette. A user-friendly LCD provides system status, and easy-to-read menus allow access to functions such as password security; deck identification; internal timers; time and date and activity search; and multichannel monitoring. Controlled by a 386-25 microprocessor, the unit from Atis allows PC access to all machine functions

Circle (394) on Fast Fact Card

Flex mounts come in four rises



The Stay-Put flex mounts eliminate the need for connecting nuts at both ends of the flex shaft. The mounts have a double-wound flex shaft and heavy-duty vinyl coating that covers the shaft, adding to its overall strength, durability and aesthetic appeal. The mounts from PanaVise are available in four rises (6", 8", 10" and 12") and are AMPS and NEC compatible.

Circle (395) on Fast Fact Card

Vibrant colors cover pagers

Snap-Ease color covers from Motorola are specifically designed for its Bravo Express pager. They come in a rainbow of colors and snap over the Bravo Express to change its color. The Fun Pack colors include vibrant pink, electric blue and cool lime, and the Classic Pack consists of forest green, sand and blue velvet covers. Each pack includes a clear pager holder.

Circle (393) on Fast Fact Card



via standard cable connection and/or modem.

Circle (394) on Fast Fact Card

Temporary antenna mounts over vehicle window edge

The AP-868 Clip-Grip temporary-mount window cellular antenna clips over the top edge of the vehicle's window, making it ideal for temporary uses such as rental vehicles. The antenna clamps tightly regardless of window thickness and when not in use can be unclipped quickly and stored out of sight. The antenna from Antenna Specialists offers 3dB gain, handles 10W of power and covers 824MHz-894MHz with better than 1.9:1 VSWR.

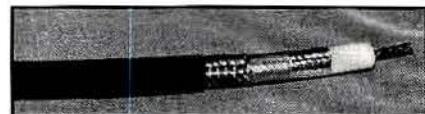
Circle (396) on Fast Fact Card

LTR repeater controller

The repeater logic controller (RLC) from IDA is designed to provide economical LTR format logic control of almost any repeater. The microprocessor-controlled RLC features quick invalidation, support of E. F. Johnson RDB and Uniden RNDL busses, second sync mode, CWID and alarm input.

Circle (397) on Fast Fact Card

Cables are flame retardant



The T-Com flexible communication cable series from Times Microwave Systems are low smoke, flame retardant jacketed flexible cables. Available in .195-, .275-, .405-, .500- and .600-inch diameters, the cables are suited for land mobile and cellular interconnect applications.

Circle (398) on Fast Fact Card

Software helps with accounts receivable

The Billing Clerk 2.0 does one-time invoicing and work orders that can be saved to disk for later recall and batch printing. The program includes recurring billing functions, either recurring invoices or statements with recurring charges. There are as many as 14 automatic recurring amounts per customer, including repair contracts, SMR billing, multiple location billing, pager billing, fax charges, voice mail and E-mail. The software from Dillware has no limitations on the number of customers you can enter.

Circle (399) on Fast Fact Card

Paging option uses modem, telephone line to route pages

The Dial-Out T.A.P. option for Zetron's 2000 series paging terminal, uses a modem and a dial-up telephone line to route pages from local telephone callers to the paging terminals of other service providers or a nationwide paging system. Because Dial T.A.P. uses the Telocator protocol, most paging terminals can receive the pages. Sixteen telephone numbers may be dialed, allowing multiple destinations. The Dial-Out T.A.P. option can be initiated in most of the same ways that standard pages are initiated: in response to a voice mailbox deposit, as part of a group page or via an incoming page from a TNPP network.

Circle (400) on Fast Fact Card

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ICOM

New products

Antenna measures 44" long

The BMEF-8350EX series of extra tall elevated-feedpoint antennas operate in the 806MHz-896MHz frequency range. The unity gain antennas from **Maxrad** feature an oversized heavy-duty shock spring and thick-wall fiberglass body. The antenna measures 44" long.

Circle (401) on Fast Fact Card

Communications network operates in 902MHz-928MHz range

The VoiceNet 2000 wireless digital voice communications network from **Repcos** operates in the 902MHz-928MHz frequency range. As many as 16 full-duplex voice channels and connections to as many as 16 additional telephone or intercom lines can be configured. Portable units can make telephone calls or selectively call individual portables or groups of portables. Because the VoiceNet 2000 uses spread spectrum, no FCC site license is required to operate the system.

Circle (402) on Fast Fact Card

Portable trunking radio features LTR, Privacy Plus formats

The HX581T is a fully compatible portable radio with LTR and Privacy Plus trunking formats. The radio also operates as a conventional 10-channel 800MHz radio. The **Standard Communications** radio features transmit, busy and call indicators. Programming and tuning are done with an IBM-compatible computer.

Circle (403) on Fast Fact Card



Fleet management system offers AVL, mobile data, vehicle security

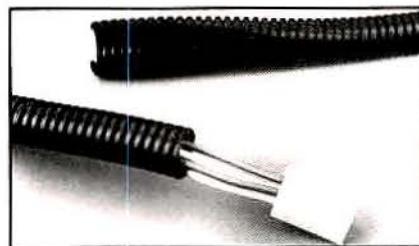
Fleet Director from **PacTel Teletrac** combines wireless automatic vehicle location, mobile data communications and vehicle security into an integrated equipment, software and service package. The fleet management system is designed for small and large fleets and offers two-way messaging, confirmed message receipt, message store and forward, driver status reports, stolen vehicle recovery, emergency alerts and vehicle sensor alerts. Fleet Director will be available commercially in Los Angeles, Chicago, Detroit, Dallas-Ft. Worth, Houston and Miami in May 1993.

Circle (404) on Fast Fact Card

Corrugated tubing provides quick bundling, wire protection

Slit-Tube is a corrugated black polyethylene tubing that is slit lengthwise for quickly bundling wires and cables. The corrugation provides the rigidity to protect the bundled wiring from crushing and abrasion. Flexible and lightweight, the tubing from **M.M. Newman** is available in 11 standard sizes from 1/4" to 2".

Circle (405) on Fast Fact Card



Software programs analyze terrain data, RF loss predictions

TPath and RFPATH are two Windows-based programs available from **Communications Data Services**. TPath produces graphical analyses of digital terrain data. Transmitter and receiver heights can be entered to determine whether a particular path is obstructed by terrain. RFPATH graphically represents radio frequency loss predictions superimposed on terrain representations. As many as four levels of predicted signal strength can be shown by

coloring terrain height according to user specified parameters.

Fresnel clearances, earth curvature and line-of-sight analyses can be displayed on both programs. Terrain data can be read into the program in a variety of other file formats including ASCII files, EDX Engineering, Rocky Mountain and SoftWright, permitting the use of data from several sources.

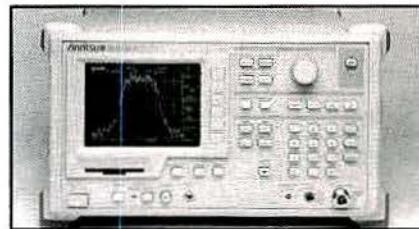
Circle (406) on Fast Fact Card

Spectrum analyzer offers adjacent channel leakage power measurement

The MS2610 and MS2620 series of spectrum analyzers from **Anritsu Wiltron** offers wide frequency ranges with built-in capabilities such as occupied bandwidth measurement, adjacent channel leakage power measurement and higher order harmonic measurement for maintenance of digital, mobile and cellular telephones. The MS2610 series features two analyzers with frequency ranges of 9kHz-4.6GHz and 9kHz-6.5GHz. The MS2620 series is for scalar applications covering frequency

ranges of 9kHz-2.2GHz, 9kHz-4.6GHz and 9kHz-6.5GHz.

Circle (407) on Fast Fact Card



Bagfones offer full-, half-duplex capabilities



The RTX 8700 series Bagfones are available in full-duplex and half-duplex models and offer 16 channels of trunking. The Bagfones from **RTX** offer hot-key dialing, last number redial, manual over-dial, backlit LCD, speed dialing, 12-number storage, ANI disable and specific channel selection. The RTX trunking radio-telephone is analogous to an office PABX telephone system. The Bagfones can readily connect with local telephone exchanges, enabling users to make and receive local, national and international telephone calls in addition to normal two-way radio usage.

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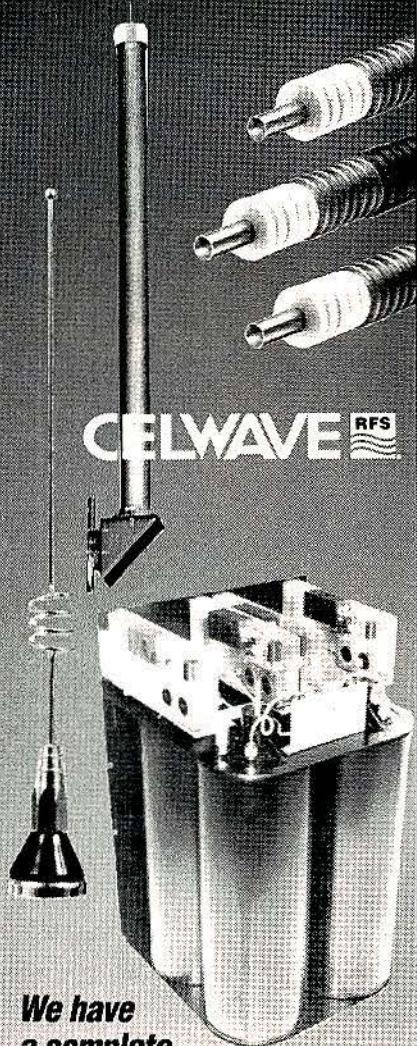
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Circle (68) on Fast Fact Card

Literature

Video tapes describe digital cellular radio

A set of nine video tapes provides a conceptual description of the technologies forming the basis of digital cellular radio, including personal communication networks. *Digital Cellular Telephony* from **Quantum Publishing** reviews the use of digital techniques in the public switched telephony network and describes the ways in which traditional technologies are inadequate for portable and mobile applications. Topics include cell arrangements, channel assignments and handoff, covering both TDMA and CDMA.

Circle (300) on Fast Fact Card

Brochure features network analyzers

A four-page brochure provides information on using RF network analyzers to measure gains, losses and efficiencies in two-way radio systems. The brochure from **Direct Conversion Technique** includes technical information on the application of network analyzers to antenna installation, as well as a table of applications and a block diagram.

Circle (301) on Fast Fact Card

Brochure describes surge suppression products

A brochure lists the complete line of **Lightning Master's** Transient Eliminator transient voltage surge suppression (TVSS) products and systems for ac, telephone and data lines. The surge suppression products and systems are used to protect high-power main distribution panels, main distribution panels, subpanels and telecommunications equipment.

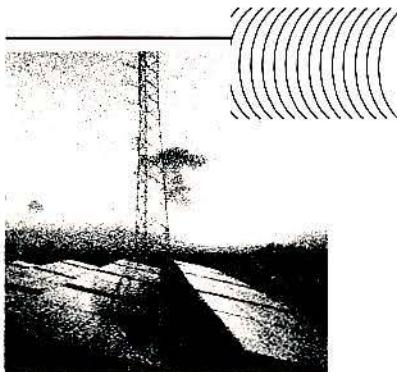
Circle (302) on Fast Fact Card

Data sheet describes controller terminal

A four-page data sheet describing the RTX 6000 controller terminal is available from **RTX**. The data sheet illustrates the operating features and advantages of the unit, a high-performance microprocessor-driven repeater controller. The data sheet covers how the controller terminal converts conventional two-way radios into trunking radio-telephone systems. A listing of the controller's operating characteristics and features is included.

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Circle (71) on Fast Fact Card

F eedback

In-house repair vs. privatization

Privatization in repair services will increase, according to 62.2% of the respondents to the November "What Do You Think?" questionnaire. Readers see the following advantages to using private repair facilities:

- "Better quality work, less overhead (because of lower parts prices). Less repeat problems, more pride on work."
- "Do not need to have inventory of parts."
- "Due to technology, special private repair facilities have the test equipment and resources."
- "Maintenance and repair during busy season, technical advice and support."
- "No need to pay a full-time in-house technician; easier; no need to stock parts or specialized test and repair equipment."

Currently 13.3% of the respondents use a private repair facility. The other respondents use the following number of technicians:

1 to 3	44.4%
4 to 6	11.1%
7 to 10	6.7%
More than 10	24.4%

Advantages those readers see in handling repair and maintenance service in-house include:

- "Able to set priorities. Able to use in-house quality control. Reduced down-time = less spare equipment."
- "Able to understand customer problems and how it affects his business."
- "Better service, more personal, less cost, customer convenience, better accountability."
- "Can repair more quickly; can do special projects; cheaper on parts and service."
- "Faster repair. Better customer service."
- "Immediate response and responsibility. Better incentive to do the job right. Not a salesman, saves company money."
- "Know how users use the equipment, not how they should use it. Special set-ups. Pride in workmanship."
- "Repairs done in-house are done faster and more efficiently because of the technicians' familiarity with equipment."

Respondents rate outside repair facilities in overall abilities and services rendered as follows:

Poor	20.0%
Fair	20.0%
Average	8.9%
Good	40.0%
Superior	6.7%
No answer	4.4%

Comments about outside repair facilities' abilities and services include:

- "Acceptable service level; however, many hidden costs surface after initial service contract initiated."
- "Can do the job, but slower turn-around time, and parts cost is higher."
- "Slow response, sloppy work, lack of qualified technicians with 'make do' attitude."
- "Most repair facilities could care less how many times you send the same pager back to them or how mad your customer is."
- "Outside repair companies are not always reliable and don't always repair things correctly the first time."



Young



Brown



Mueller



Huebner

T. Howard Noel, a partner in the architectural and engineering and planning firm of Hayes, Seay, Mattern & Mattern, Roanoke, VA, moves up to chairman. He succeeds **H. Boyd Dickenson**, who steps down after 46 years with the company.

John J. Sullivan exits Teletec, Raleigh, NC, as director of sales and marketing, to join Selectone, Hayward, CA, as its sales and marketing director.

Harry Young leaves Bellcore, Livingston, NJ, as wireless interconnection director to join the communications engineering consulting firm of Jules Cohen & Associates, P.C., Washington, D.C., as a consultant.

Appointments at Fleet Call, Rutherford, NJ:

Keith Kaczmarek departs PacTel, Walnut Creek, CA, as executive director of advanced technology, to become vice president of technology development for Fleet Call.

John Caner leaves PacTel as director of business development for the cellular wireless data division to join Fleet Call as director of wireless data development.

Charles Brown exits Midland International as its regional manager in Lincoln, NE, to join Bendix/King, Lawrence, KS, as regional sales manager.

Stan Ciepielinski departs the Square D Company in the Charlotte, NC, office as director of finance, to become chief financial officer at Glenayre Technologies, Charlotte.

Changes at Transcrypt International, Lincoln, NE:

Paul C. Mueller departs Motorola, Schaumburg, IL, as western regional business manager for secure advanced RF products, to become president of Transcrypt.

Dean Thompson leaves Lawrence, KS-based Bendix/King as product manager to join Transcrypt as director of marketing services.

John Leitt departs Electronic Design and Manufacturing, Omaha, NE, as senior design engineer to become senior development engineer at Transcrypt.

Steve Cass exits Peninsula Communications, San Francisco, as director of sales to join Transcrypt as worldwide sales director.

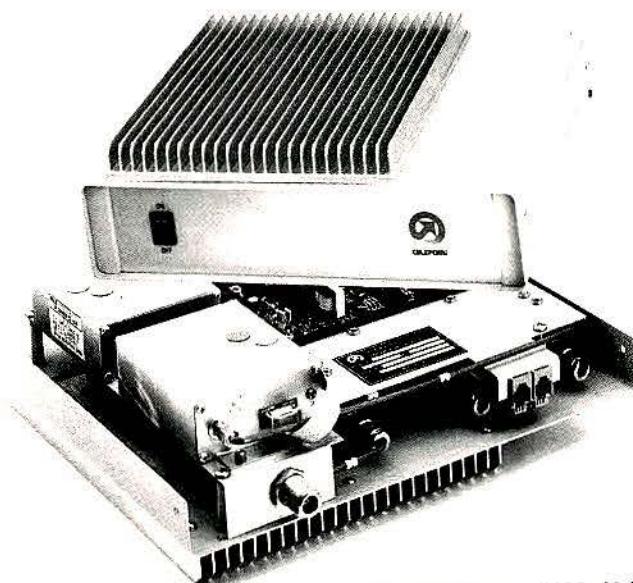
Tom Keown leaves United Automobile Association, Lincoln, as executive vice president, to become telemarketing manager at Transcrypt.

Jim Moore departs Federal Express as managing director of strategic programs to join Coded Communications, Carlsbad, CA, as vice president of strategic development.

Steve Huebner exits Spectrian, Mountain View, CA, as program manager to become major accounts manager for Raven Electronics, Sparks, NV.

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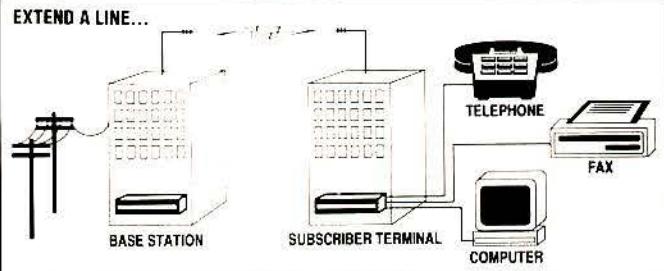


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Circle (72) on Fast Fact Card

L

Letters to the editor

Interoperability:

Communications problems during disasters in 1992 clearly demonstrated the need for public safety field radio *interoperability*, that is, the ability for various organizations to communicate despite their use of different types of radios.

The lack of widespread interoperability places the safety and lives of the general public and of public safety workers at risk. The biggest obstacle to interoperability is manufacturers' proprietary trunking standards.

When the FCC first authorized trunked radio systems, it is doubtful that the agency anticipated that suppliers would fragment the technology. At present, North America has three proprietary trunking standards in common use, one from Motorola, another from E. F. Johnson and a more recent third from Ericsson GE.

Once a user implements a trunked system, it isolates itself from others with non-compatible trunked systems. This isolation may result, for example, in a city police department, a county sheriff's department and a city fire department working in the same area with mobile and portable radios on different trunked systems. The members of one department cannot use the trunking mode to communicate with members of the other two departments when it may be critical to do so. This situation is hazardous.

Project 25, a joint effort of the Associated Public-Safety Communications Officers (APCO), the National Association of State Telecommunications Directors (NASTD) and certain federal radio users to develop digital trunked radio standards, has not resolved the interoperability issue.

Public safety radio users by themselves may not have the power to force the issue of interoperability, and they should not be left alone to do it. It is time for the FCC to step in and to mandate solutions. The fragmentation of trunked radio standards limits technology availability, reduces competition and isolates public safety radio users. These factors tend to negate the benefits of trunking technology.

The FCC should mandate that proprietary claims on trunked technology should be limited to the fixed devices that provide actual trunked performance, such as the trunking repeaters. It should mandate open trunked systems access for all mobile and portable radios that need to access those trunked system devices.

Trunking technology developers could gain returns on the research and development investments through prices for their remaining proprietary fixed devices. Suppliers then would have the option to provide users with mobile and portable equip-

ment that can *interoperate* on any installed trunked system simply by providing those devices with the software intelligence to work on any system.

There is a precedent for such action. Remember the old days of the Bell System and its closed network access? The trunked radio system interoperability problem is similar. As with the old Bell System, the barriers to trunked radio network access are detrimental to the public and prevent trunking from being used according to the FCC's original good intent.

Government-imposed open trunked system access may act to raise the cost of fixed trunking devices as their full research and development costs are allocated to them, but it can reduce the prices or significantly enhance the capabilities of mobile and portable radios that work through the fixed devices, or both.

Public safety workers who agree that the government should impose open trunked system access should make their opinions known to APCO leaders and to the FCC. People who lead other kinds of organizations that use trunked radio communications and who want open trunked system access should make their feelings known to trade associations that represent them and to the FCC.

Without a timely solution, the problem of limited interoperability will worsen as trunked technology migrates into the lower radio frequency bands and as more suppliers' proprietary trunking methods enter the market.

As the protector of the public interest in issues involving radio spectrum use by state and local government and the private sector, the FCC should step in and should force the solutions to the serious and growing problem of trunked radio equipment interoperability.

Rand Ellis
Marketing Manager
Radio Systems
Ft. Lauderdale, FL

Fast Fact Card comment:

The two toughest problems facing me on the job are:

- convincing older system users to invest in trunking systems.
- convincing users that the horrible audio quality of DES-XL is normal, and nothing is wrong with the radio.

David A. Williams
Electronics Technician
Argo Fire Department
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Contact Jennifer Hinkle at (913) 967-1927 or fax (913) 967-1901 to place your classified ad. Or send your advertising materials and order to Tammy Kaflebaugh, Mobile Radio Technology, Classified Advertising Department, 9800 Melcalf, Overland Park, KS 66212.

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405-430MHz	4W	6F	\$325
450-470MHz	4W	2F	\$300
450-470MHz	4W	6F	\$325
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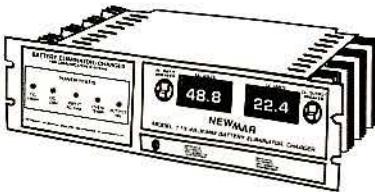
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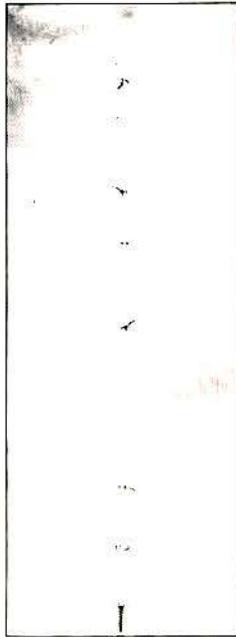
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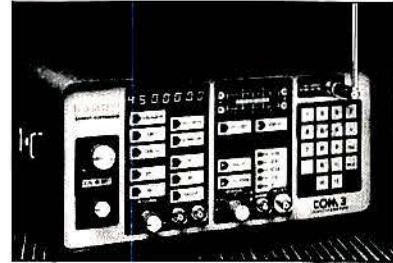
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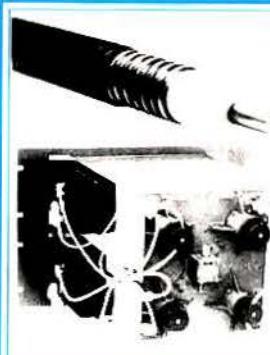
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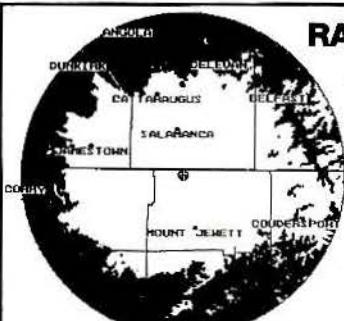
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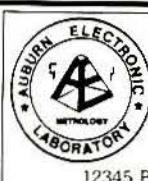
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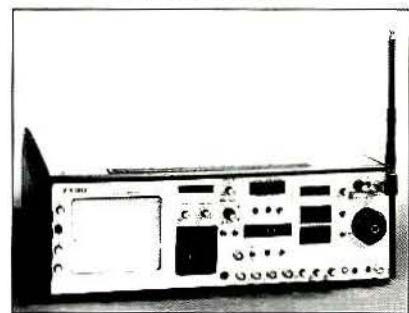
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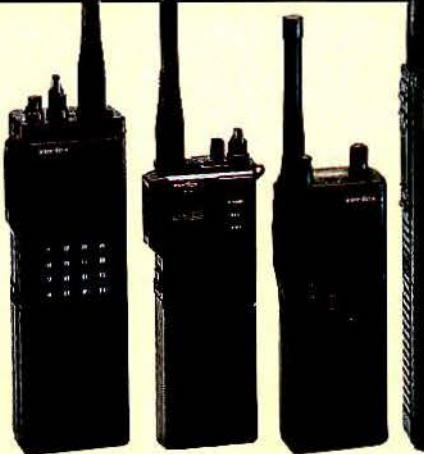
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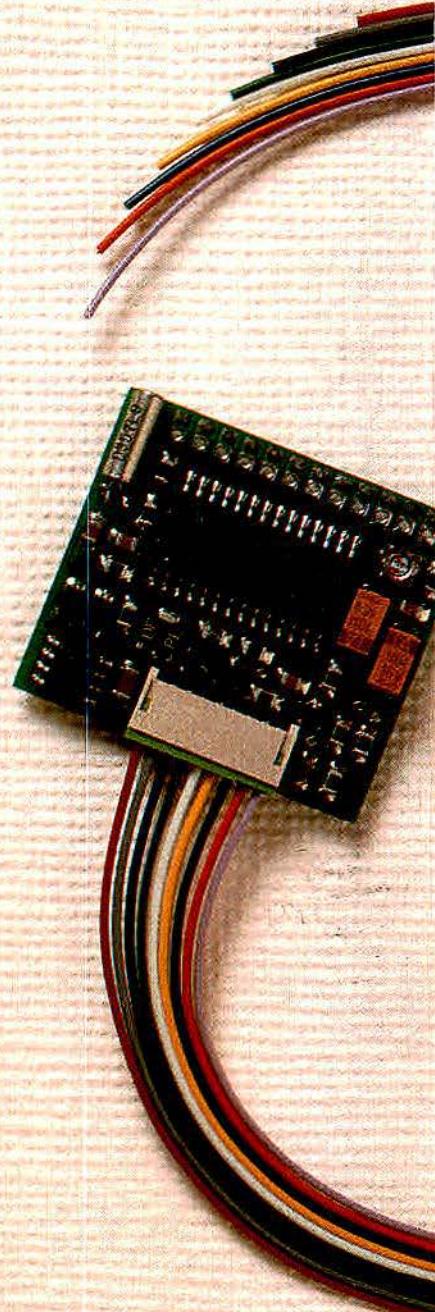
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